VOLUME 43 NUMBER 5

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PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO 10, ILLINOIS. ANNUAL SUBSCRIPTION, $12.00

Entered as Second Class Matter Feb. 7, 1939, at the Postoffice at Chicago, Under the Act of Congress of March 3, 1879

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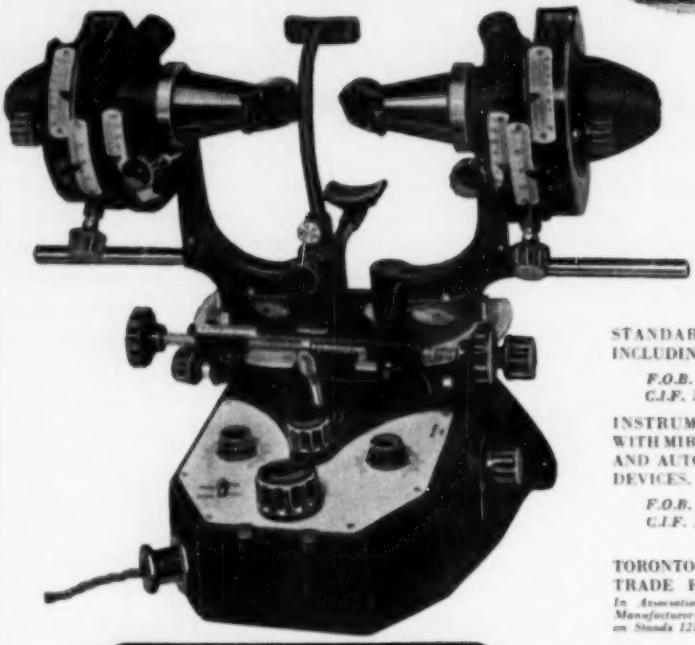

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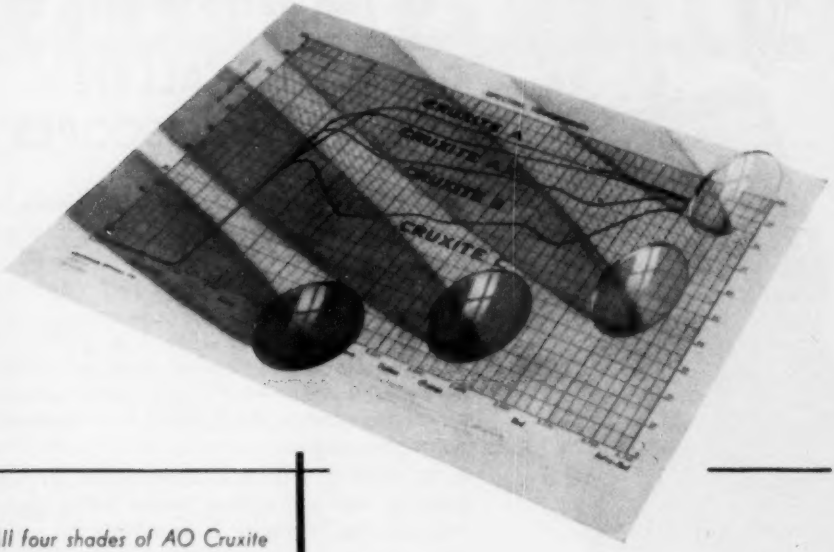

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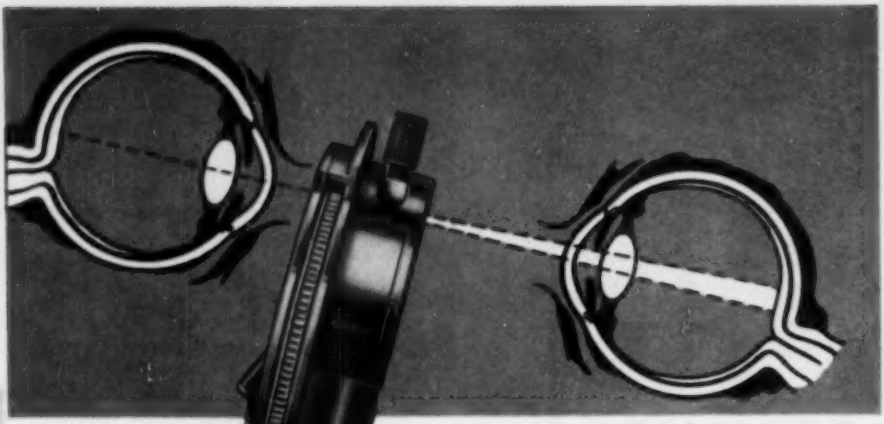

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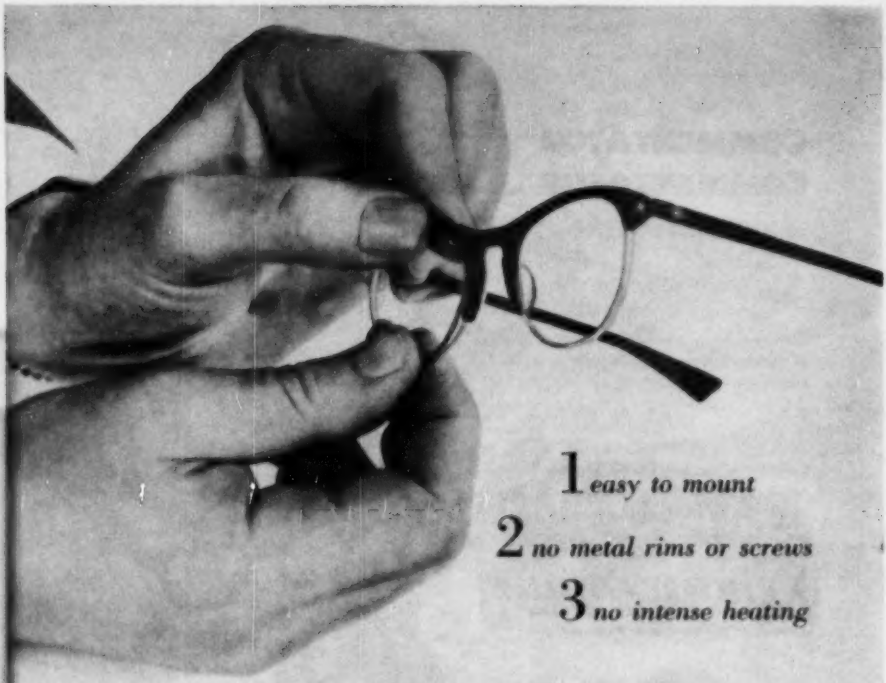

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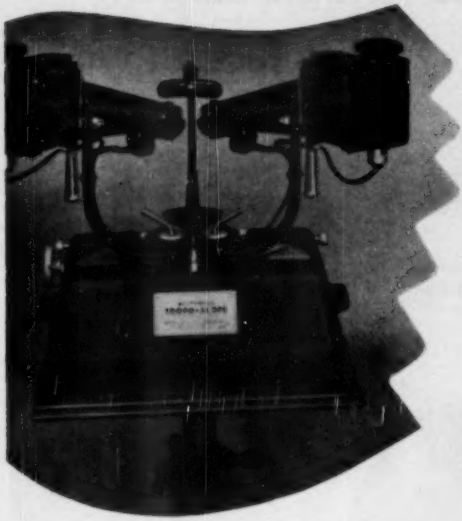

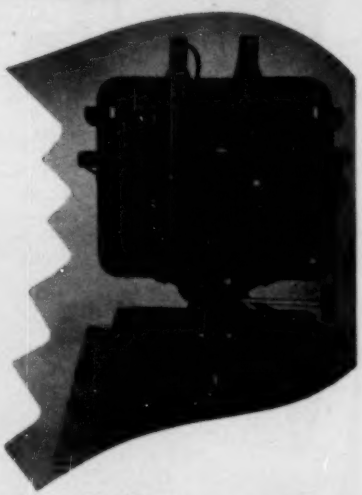

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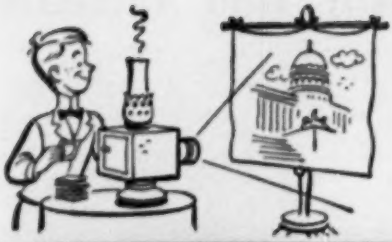

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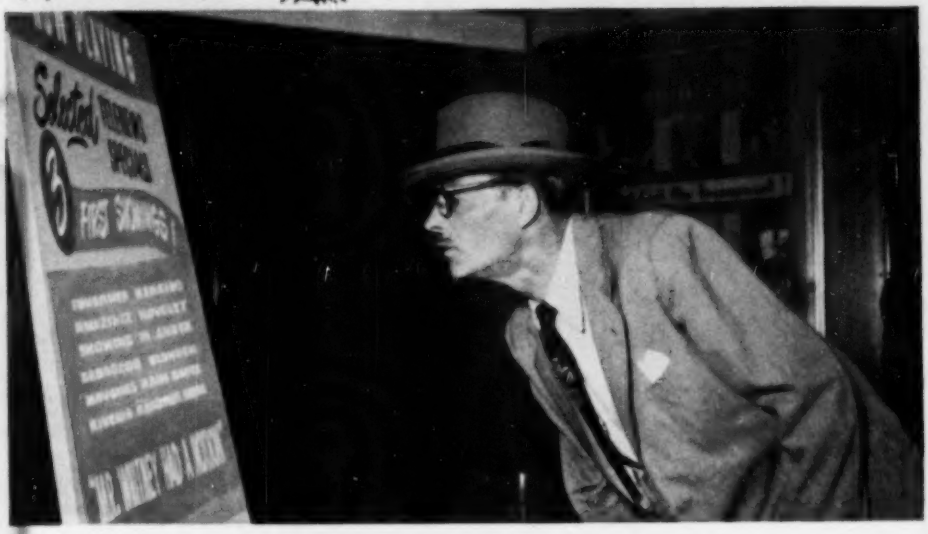

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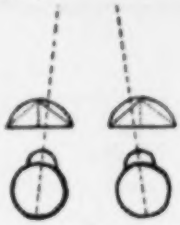

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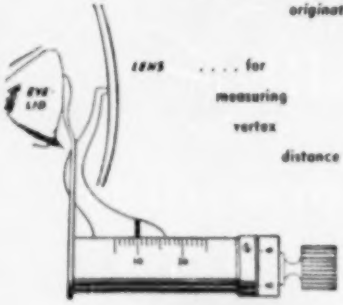

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ARCHIVES OF OPHTHALMOLOGY

VOLUME 43 MAY 1950 NUMBER 5

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CYCLODIALYSIS: ITS MODE OF ACTION

Histologic Observations in a Case of Glaucoma in Which Both Eyes Were Successfully Treated by Cyclodialysis

OTTO BARKAN, M.D.
SAN FRANCISCO

IN THIS communication the mode of action of cyclodialysis is interpreted on the basis of histologic observations in 2 eyes operated on for chronic glaucoma. Tension was successfully normalized by cyclodialysis and remained so from the time of operation until the patient's death, fifteen months later. Gonioscopic findings in similar cases are coordinated in the study, and certain surgical conclusions are drawn.

Heretofore, histologic examination of eyes treated by cyclodialysis has been performed only in cases in which the operation failed, with 1 exception. This was an eye operated on by Elschnig [1] in which tension was normalized for fifteen years, from the date of operation until the patient's death. The upper inner part of the anterior chamber (untouched by the cyclodialysis spatula) showed broad glaucomatous synechias of the root of the iris. Schlemm's veins were partly occluded. In the region of cyclodialysis the synechias were separated from the corneoscleral trabeculum, which was completely free. The ciliary body and the root of the iris were separated by a wide cleft from the thin and sclerosed trabeculum. A communication had been created between the anterior chamber and the suprachoroidal space, which undoubtedly permitted drainage of fluid from the chamber. Heine's postulate for the basis of efficacy of cyclodialysis had thus been fulfilled. However, it was not entirely possible to exclude the role that may have been played by decreased production of fluid following damage to the ciliary body. Opening of the angle of the chamber by separation of the peripheral synechias could hardly have been a significant factor in the reduction of tension, since at the places where such opening had taken place the trabeculum appeared compressed and sclerosed and the outflow of fluid probably could not have taken place. It was considered that some significance might be attributed to stretching of the iris vessels in the detached area.

1. Elschnig, A.: Zur Wirkungsweise der Cyklodialyse, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **90**:21, 1933.

Since Elschnig's report, gonioscopy with the binocular microscope [2] has supplied important information on the action of cyclodialysis. It was shown by Vannas [3] and by me [4] that the formation of a cleft between the anterior chamber and the suprachoroidal space is a *sine qua non* of successful cyclodialysis. This was confirmed by Sugar [5] and by Clarke.[6]

A case is reported in which the 2 eyes were successfully treated by cyclodialysis.

HISTORY OF CASE

History.—Mrs. A. C., aged 68, was first seen on the evening of June 19, 1934. For the preceding two years she had had recurrent attacks of congestive glaucoma of the left eye. Vision in this eye had been entirely lost two weeks before. Vision in the right eye had also failed during the interval, but she had been able to count fingers until the afternoon of June 19, when an attack in the right eye resulted in nearly total blindness. Vision was limited to seeing hand movements in the temporal field of the right eye and to light perception in the left eye. Tension was +3 in each eye. The patient had stopped using miotics two weeks previously. The eyes were injected; the corneas steamy, and the anterior chambers shallow, the left being more so than the right. The pupils were central, and equal, the diameter being 4 mm. The patient was disoriented; she had had a series of strokes in the course of the last twelve years.

Right Eye.—Operation: The same evening, with the patient under general anesthesia (vitrous oxide and oxygen), cyclodialysis was performed on the lower outer quadrant of the right eye, after retrobulbar injection of 4 per cent procaine hydrochloride with epinephrine hydrochloride (1:1,000). A small iridodialysis resulted. There was only a slight amount of hemorrhage into the anterior chamber. The next day the right eye was soft to digital palpation and remained so thereafter. The cornea was brilliant. The hemorrhage was absorbed. Vision returned to counting fingers at 7 feet (2.1 meters). Normal tension and vision for counting fingers at 7 feet were maintained in this eye until her death, Sept. 9, 1935, fifteen months after the operation.

Microscopic Study: The section was made obliquely from the center of the insertion of the external rectus muscle to a point a little nasal to the inner border of the superior rectus muscle (fig. 1).

The outer end of the scleral incision was situated about 5 mm. behind the limbus, and the incision traversed the sclera in an oblique direction. The ciliary muscle was detached from its insertion, but in such a way that a short stump of muscle fibers remained hanging from the scleral spur. The spatula had evidently perforated the muscle near its insertion, instead of the muscle attachment, and at

2. Barkan, O.; Boyles, S. F., and Maisler, S.: On the Genesis of Glaucoma: Improved Method Based on Slitlamp Microscopy of Angle of Anterior Chamber, Am. J. Ophth. **19**:209-215, 1936.

3. Vannas, M. V.: Zykloskopische Untersuchungen über das Verhalten des Strahlenkörpers nach der Heineschen Operation, Klin. Monatsbl. f. Augenh. **95**:629, 1935.

4. Barkan, O.; Boyle, S. F., and Maisler, S.: On the Surgery of Glaucoma: Mode of Action of Cyclodialysis, Am. J. Ophth. **19**:21-25, 1936.

5. Sugar, S., in Berliner, M. L.: Biomicroscopy of the Eye: Slit Lamp Microscopy of the Living Eye, New York, Paul B. Hoeber, Inc., 1943, vol. 1, 642-643.

6. Clarke, S.: Gonioscopic Observations in Cyclodialysis Operations, Am. J. Ophth. **24**:1026-1028, 1941.

the same time had produced an iridodialysis a little over 1 mm. in extent. Whereas the peripheral border of the dialyzed iris retracted 1.5 mm. toward the pupil, the torn edge of the ciliary muscle retracted an equal amount posteriorly. Along with the retraction of the longer fibers of the muscle, the whole ciliary body was rotated so that the ciliary processes turned forward and came to lie almost in the direction of the iris. The change in the picture of the ciliary body which was caused by this rotation was recognized through the position of the circular portion of the

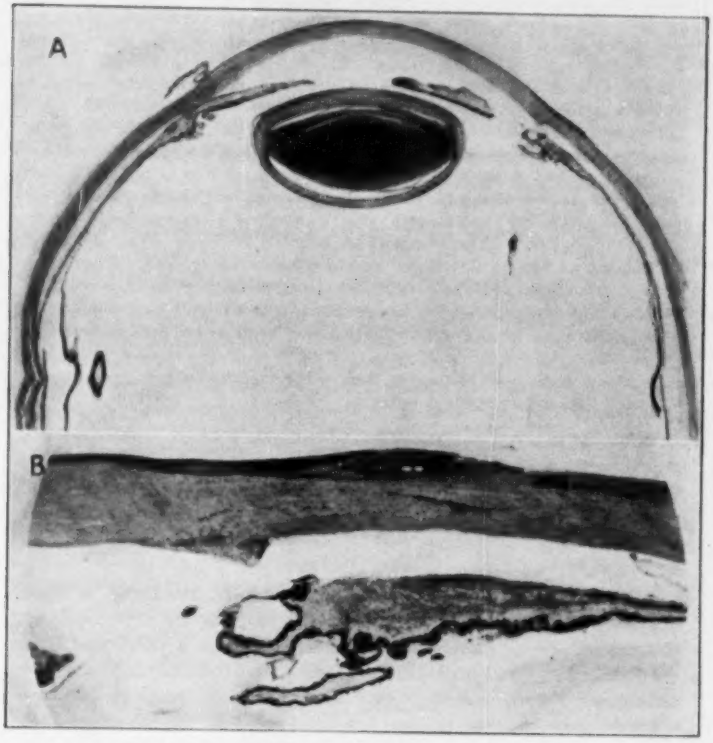

Fig. 1.—Right eye. Detachment of the ciliary body. There is a free communication, or cleft, from the anterior chamber to the suprachoroidal space. A small iridodialysis is present. The anterior synechia is abolished. The stroma of the iris was strikingly well preserved in the dialyzed portion. × 5.

B, detail of *A*, showing separation of the ciliary body. The corneoscleral trabeculum is markedly impregnated with pigment granules. Schlemm's canal is patent, of narrowed caliber and permeated with pigment. × 30.

muscle, which no longer lay internal to the longitudinal muscle, but was turned anteriorly. Through this rotation the origin of the ciliary processes was approximated to the tissue remnant which had remained on the spur. They were, how-

ever, separated from it by a flap, which remained open, and which constituted an open communication or cleft between the anterior chamber and the supercilliary space. It is questionable whether the fine space which extended to the equatorial region between the ciliary body and the sclera, 0.5 mm. in width, existed in the living eye as an open space or whether it was formed in the cadaver during fixation of the eye. In favor of the latter possibility is the fact that on the opposite side of the eye the ciliary body was separated from the sclera by a space of about equal size and proportion, which began at its attachment to the ciliary body. No particular difference in the condition of the ciliary body could be made out at the site of the operation or far distant from it. The ciliary body was markedly sclerosed throughout and degenerated. The muscle was very atrophic, and the connective tissue was much increased. The corneoscleral trabeculum throughout was conspicuously impregnated with pigment granules. However, there was a difference in its texture in various locations. Whereas in the presence of the peripheral anterior synechia it was extremely tough and compressed, it appeared somewhat loosened in the area of the undermining; and it is quite probable that it had again become permeable to aqueous in this region. Schlemm's canal was patent throughout its circumference, though of narrowed caliber, and was permeated with pigment. The stroma of the iris was extremely well preserved in the dialyzed portion. This was the more striking in that its tissues showed pronounced changes in all other portions, especially in the pupillary region, where the tissue had become completely homogeneous, with scattered pigment tufts. It would appear that the separation of the anterior synechia had been of benefit to the iris tissue.

In the posterior part of the eye there was total glaucomatous excavation of the disk. The optic nerve was atrophic.

Summary and Conclusions.—Cyclodialysis caused a fundamental change in the region of the anterior chamber. The longitudinal fibers of the ciliary muscle were perforated by the spatula near their attachment to the scleral spur. The torn ends of these fibers had retracted far posteriorly. No new attachment between the ciliary body and the sclera had taken place.

The anterior synechia was abolished, the more thoroughly as iridodialysis took place. The entrance to the chamber angle was opened, and thus access to the trabeculum and to Schlemm's canal was again made possible. The lamellas of the corneoscleral trabeculum, which were compressed by the synechia, were definitely freer, although not to a notable degree; thus the aqueous may have found its way into Schlemm's canal. Probably this occurred only to a restricted degree, for the lamellar meshwork of the ligament was partially obstructed by pigment that had been carried into it at a former period or had migrated there from the stroma of the iris which was in contact with it.

Since the detached ciliary body had not grown on to the sclera, a free communication, or cleft, from the anterior chamber to the suprachoroidal space was established. Anatomic examination alone does not permit a positive decision concerning whether the free space which extended to the equatorial region in the enucleated eye after fixation

existed as such in the living eye. The anatomic evidence, however, indicated that it was possible for aqueous to find its way into this space. Any excess pressure in the anterior chamber must have been able to press fluid backward through the cleft. Changes in the position of the ciliary body with variations in the size of the aperture (suction action) or contraction of the muscle fibers may have aided in this process. Iridodialysis may also have contributed by making more accessible the route for passage of intraocular fluid from the vitreous and posterior chamber to the anterior chamber. The lower the intraocular pressure, the less would the ciliary body have been pressed against the sclera, and the more easily could the cleft have opened, or perhaps have remained open (fistula formation).

The supraciliary cleft present in the histologic sections in this case is demonstrable by gonioscopy in vivo in all cases of successful cyclodialysis.

These findings illustrate the reason for the permanent postoperative use of miotics, as suggested in a previous article,[7] namely, that closure of the cleft be prevented and permanency of the result assured.

Whether or not the operation had any effect on the histologic condition of the ciliary body is questionable. The ciliary body was in poor condition throughout, the ciliary processes everywhere showing signs of degeneration, as is usual in advanced glaucoma. Since atrophy of the ciliary body is a gradual process, it must have been in progress for a considerable time prior to operation. A further argument against the possibility that atrophy of the ciliary body occurred after operation and resulted in reduction of intraocular pressure is the clinical fact that the eye was soft immediately after operation and stayed soft. Whatever was the initial cause of glaucoma in this case, it is evident that at this advanced stage, in which a peripheral anterior synechia prevented access to the angle of the chamber, hardness of the eye became permanent as the result of blockage to the outflow of aqueous. Thus, one arrives at the conclusion that a new channel of outflow must have formed, accounting for the lasting good results of cyclodialysis.

Another argument against atrophy of the ciliary body as the cause of permanent reduction of tension after cyclodialysis is the clinical fact that after years of greatly reduced pressure, a sudden increase, indeed an attack of glaucoma, can occur.[8] I have observed such a sudden rise after successful cyclodialysis in 5 cases. In 1 case the operation had been performed two months, and in another two years, previously. The sudden rise in tension could be explained in no other way than by sudden closure of the cleft, which caused complete blockage of outflow.[7]

7. Barkan, O.: Cyclodialysis, Multiple or Single, with Air Injection, Am. J. Ophth. **30**:1063-1073, 1947.

8. Meller, J.: Personal communication to the author.

The immediate response to closure of an acute attack of glaucoma suggests active secretion from a functioning ciliary body. It may therefore be concluded that function of the ciliary body was not materially impaired by cyclodialysis and that the action of the operation is probably due solely to the formation of a cleft.

Left Eye.—Operation: After cyclodialysis was completed on the right eye, the left eye was subjected on the same evening (June 19) to the following procedure: With the keratome a small oblique incision was made in the cornea near the limbus at 2 o'clock, just sufficient to permit the entrance of a narrow spatula. This instrument was passed across the anterior chamber, and an attempt was made to separate the adhesion and open the angle on the opposite side of the chamber through blunt dissection by pressing down on the root of the iris from 7 to 9 o'clock. As the spatula was swept around, the anterior chamber was lost. The next day there was subjective relief, but the pressure of the left eye was still high. Three days later, with the patient under general anesthesia (nitrous oxide and oxygen), after preliminary injection of 3 cc. of epinephrine hydrochloride (1:1,000) at the apex of the orbit, cyclodialysis was performed on the left eye in the lower outer quadrant. Several minutes after the injection the pressure fell to 18 mm. (MacLean). The cyclodialysis was done without loss of aqueous and without hemorrhage into the anterior chamber. Three days after operation the intraocular tension was normal and remained so until the day of the patient's death. She was seen a few days before death, when vision was equal to counting fingers at 7 feet in the right eye and was entirely lost in the left eye. Ophthalmoscopic examination showed total excavation and atrophy of the optic nerve, the fibers showing greater loss in the left nerve than in the right. Tension to digital palpation seemed well within normal limits. Both eyes were pale and comfortable and had been so ever since the operation, a period of fifteen months. The corneas were brilliant and clear. Because the patient was somewhat disoriented, it was impossible to make a gonioscopic examination.

Microscopic Study (fig. 2 *A* and *B*): The eyeball was sectioned in an oblique direction from 2 to 8 o'clock to permit study of the nasal half of the chamber angle and to determine the influence of the first operation on the peripheral anterior synechia and the internal scleral sulcus. The optic nerve showed total glaucomatous excavation with complete atrophy of nerve fibers. The anterior part of the eyeball showed a peripheral anterior synechia, almost complete hyaline degeneration of iridic tissue in the pupillary part of the iris with interspersed pigment clumps and complete disintegration of the pars iridica retinae. The ciliary part of the retina was well preserved. The ciliary body and its processes were uniformly atrophic everywhere.

The changes in Descemet's membrane (lamina elastica posterior) and in the chamber angle which were visible throughout a large area in the outer and lower part of the bulbus were as follows:

1. Detachment and some folding of Descemet's membrane.

2. Separation of the peripheral anterior synechia from its point of attachment on the scleral wall. It was separated by a narrow space or connected by loose areolar tissue.

3. Detachment of the ciliary body. This took place in part throughout the innermost layers of the sclera, so that a few bundles of scleral fibers remained attached to the origin of the ciliary muscle fibers. Detachment occurred especially in the upper and outer part, where a slit led from the anterior chamber into the

suprachoroidal space. The latter appeared widened to just behind the ora serrata up to about 1 mm., owing to flat detachment of the ciliary body, and was patent. A picture similar to that in the right eye was encountered on examination of the left eye. That this space was patent in the section is not proof that it was equally patent in the eye during life, for the tissue space may have arisen only during

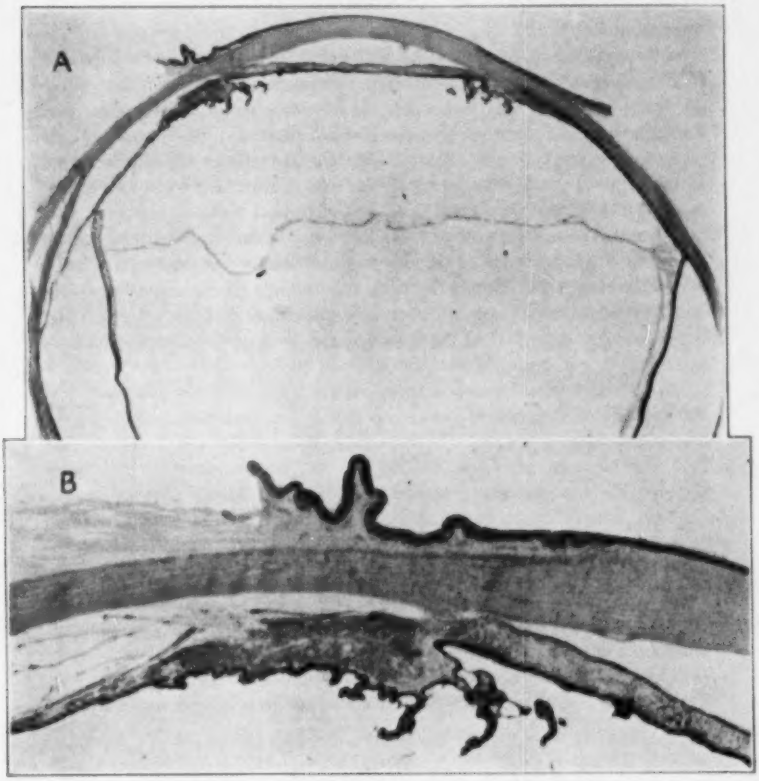

Fig. 2.—Left eye. *A*, section showing, on the temporal (left) side, the ciliary body separated and a narrow cleft extending into the anterior chamber. On the nasal side the scleral spur is pushed back; little of the normal trabeculum is left. There is no trace of the canal of Schlemm. × 5.

B, detail of *A*, showing separation of the ciliary body and a narrow cleft. × 25.

fixation. However, it is apparent that the space was clear, and, considering the open communication with the anterior chamber, it must have been accessible to the contents of that chamber. The gonioscopic findings characteristic of this type of

glaucoma suggest that the cleftlike space present in the histologic sections must also have been present in vivo. On the inferior side of the bulbus the space closely bordered the sclera.

4. Partial detachment of the peripheral anterior synechia and unfolding of the lamellas of the corneoscleral trabeculum in the lower part of the bulbus, thus opening the internal scleral sulcus. Thus an open communication between the internal scleral sulcus and the anterior chamber was created. The canal of Schlemm had disappeared.

Conclusions.—One cannot be far wrong in attributing the opening of the internal scleral sulcus to the preliminary procedure, in the course of which a spatula was introduced from an upper outer direction into the chamber and pushed downward and inward. Sliding along the posterior wall of the sclera, it first detached the peripheral anterior synechia, then reached the front of the scleral spur and had to enter the internal scleral sulcus. This tore and unfolded the corneoscleral trabeculum. The absence of any trace of the canal of Schlemm within the opened sulcus may be readily understood; it evidently had been obliterated for some time in the long-standing glaucoma. This probably explains why the preliminary operative procedure had no effect on the intraocular pressure. Thus the histologic, as well as the clinical, observations prove that cyclodialysis (detachment of the ciliary body from the sclera, producing a communication between the anterior chamber and the suprachoroidal space) was responsible for permanent lowering of the intraocular pressure. It appears certain from the sections that cyclodialysis was effective because of the communication it formed between the anterior chamber and the suprachoroidal space.

SURGICAL ASPECTS

In this case the typical history and clinical findings of "chronic congestive," or narrow angle (iris or angle block), glaucoma[9] in the late stage are presented. Permanent adhesions had closed the angle of filtration and were associated with chronic decompensation and periods of subacute and acute congestive exacerbation. Owing to the patient's mental state, it was impossible to make a gonioscopic examination. However, judging from gonioscopic findings in similar cases and from the microscopic sections in the present case, it appears most likely that preoperative gonioscopy would have shown the angle closed by peripheral adhesions of the iris. In the prodromal stages gonioscopy would no doubt have shown a narrow angle associated with a shallow chamber and a normal trabeculum. In the typical development of this case of narrow angle glaucoma over the years, recurrent closure of the angle associated with congestive attacks had evidently taken place, resulting in the formation of permanent peripheral adhesions. Since cyclodialysis

9. Barkan, O.: Choice of Operation in Glaucoma, Am. J. Ophth. **24**:1-11, 1941.

clefts seen by gonioscopy are often not more than a small fraction of a millimeter wide, it is not surprising that such a cleft appears extremely narrow in the microscopic sections, quite apart from any shrinkage that may have occurred from the fixation fluid.

Considering the presence of peripheral adhesions in this case, it is suggested that an external fistulizing operation would have had little, if any, success and would have been associated with considerable hazard. In the case of the right eye, it is evident that iridectomy would have been of no avail unless the adhesions in the angle had first been separated. But even after such a separation a permanent effect would have been doubtful in view of the almost entire lack of permeability of the trabeculum. In the case of the left eye, since Schlemm's canal was absent, iridectomy would certainly have been useless, unless an external filtrating scar had formed accidentally. It is suggested, as shown by the successful result of cyclodialysis in this case, in which anatomic sections were made, and by similar experiences with cases of the same type studied gonioscopically,[10] that cyclodialysis is indicated, especially in the late stage of narrow angle (angle or iris block) glaucoma in which extensive adhesions in the angle have formed.

Prof. J. Meller and Dr. P. Kronfeld aided in interpreting the microscopic sections.

490 Post Street.

DISCUSSION

DR. FREDERICK C. CORDES, San Francisco: In 1905, at the Heidelberg congress, Heine presented his method of cyclodialysis. It was suggested to him by E. Fuchs, who gave detailed descriptions of the choroidal detachment, accompanied with diminution of intraocular pressure, following iridectomy for glaucoma and extraction of caratact. By the surgical procedure he described, Heine hoped to produce a detachment of the choroid that would reduce the intraocular tension. The theory on which the operation was based is now known to have been incorrect. The method found great favor on the Continent and was used extensively for a number of years, but finally lapsed into partial oblivion except with a few eminent operators. In recent years it has come into favor again, especially since the introduction of gonioscopy. It has been selected by some as the operation of first choice for chronic noninflammatory glaucoma. Gradle stated the belief that the operation was indicated for all forms of primary glaucoma except the inflammatory glaucoma of the noncompensated type.

Spaeth, in his book, stated that microscopally only a partially detached, degenerated ciliary body has been demonstrated after the operations. With the gonioscope, however, it has been shown that in the cases of successful cyclodialysis, there has been established a cleft between the anterior chamber and the suprachoroidal space.

10. Barkan: Footnotes 7 and 9.

The two eyes studied by Dr. Barkan show that as a result of the operation the peripheral anterior synechia was broken up and the ciliary body detached, with a cleft that communicated between the anterior chamber and the suprachoroidal space. In both eyes the ciliary body showed not a localized degeneration but a generalized pathologic change, probably due to the glaucomatous process. A study of the paper and the microscopic sections is rather convincing that the mode of action of cyclodialysis is through the establishment of an opening between the anterior chamber and the suprachoroidal space.

Dr. Barkan states that "cyclodialysis is indicated especially in the late stage of narrow angle glaucoma, in which extensive adhesions in the angle have formed." This is a new conception of the indications for the operation. From the series of cases reported by the Wilmer Institute and others, it would seem that cyclodialysis offered the best chance for success in cases of deep chamber glaucoma when done in the area where there were no anterior synechias. This has been my own experience, and I have felt that gonioscopy was an important factor in that it made it possible to determine the area in which there were no adhesions; I feel that if the operation is done in this area the chances for success are materially increased.

On the other hand, it is true that in cases of glaucoma associated with aphakia, cyclodialysis has been used almost universally as the operation of choice, even in the presence of anterior synechias, and on the whole the results have been gratifying.

Certain details of the operation bear emphasis. The breaking of the adhesion with the least trauma seems of importance, and the operation of inverse cyclodialysis, as advocated by Dr. Shaffer in a paper which will soon appear, is worthy of consideration. In this procedure the adhesions are broken up from behind the ciliary body into the anterior chamber. The injection of air after the operation in an attempt to keep the adhesions from reforming also seems important. My associates and I have used air successfully; but, as Dr. Barkan has pointed out, care must be taken, as the injection of too much air, with an increase in tension, may lead to complications.

Dr. Barkan presents a new idea in the treatment of the late stage of narrow angle glaucoma which seems to be substantiated by the material presented.

Dr. Dohrmann Pischel, San Francisco: These sections show convincingly that a definite pathway between the anterior chamber and the suprachoroidal space has been created by the cyclodialysis. Formerly it was postulated that this was the case, and more recently, by means of the gonioscope, one was able to see a cleft, or space, which was believed to be connected with the suprachoroidal space. Now, the final proof of Dr. Barkan's histologic specimens confirms this theory.

How this open cleft "keeps an eye soft" is indicated by other experimental work. It has been shown that if india ink is injected into an eye in which the choroid is bared by a retinal detachment with a tear, almost all the ink is carried to, and absorbed by, the vascular bed of the choroid, which has strong powers of absorption. Therefore it is probable that in a glaucomatous eye in which a cyclodialysis has been performed the aqueous is absorbed by the choroid, laid bare, so to speak, by the operation.

In view of this, it is important to do everything possible to keep the cleft open. One means is to perform the operation, whenever possible, in the upper half of the globe. Then, in case of hemorrhage into the anterior chamber, the blood will run down into the lower part of the chamber and leave the angle in the area of operation free, and the cleft free, from the danger of being closed by the blood clot.

As Dr. Barkan mentioned, it is advisable to use miotics to help in keeping the cleft open. One must be on the lookout, however, for the appearance of posterior synechias. These often develop insiduously. The pupil may appear to be reacting well, but, unless close observation is maintained, the formation of even an annular synechia may be overlooked.

Therefore, when one is in doubt, the pupil should be briefly dilated with eucatropine hydrochloride or epinephrine hydrochloride (1:100), or even stronger drugs; then, when it is seen to be free from adhesions, it may again be contracted with miotics. It is a good idea perhaps, as a routine, to dilate the pupil in this way every four or five days as a safety measure.

In corroboration of Dr. Barkan's suggestion of cyclodialysis in treatment of late narrow angle glaucoma, I can state that it worked well in my hands in 2 cases.

DR. OTTO BARKAN, San Francisco: I am obliged to Dr. Cordes and Dr. Pischel for their interesting discussion. That cyclodialysis is effective in cases of narrow angle glaucoma in the advanced stage, in which the angle is closed by adhesions, is borne out by the histologic observations in the present case and by those in the case reported by Elschnig. My experience in the last 100 cases of primary glaucoma treated by cyclodialysis shows that 15 were of this type and 85 were of the wide angle type (normal or deep chamber). As has been emphasized in previous articles, these are the types of primary glaucoma for which cyclodialysis is especially indicated.

Preoperative gonioscopy is, I feel, of value chiefly in determining the type of glaucoma rather than the area in which there are adhesions. I have found that in cases of wide angle glaucoma adhesions are not present until the late degenerative stage of absolute glaucoma. When present in narrow angle glaucoma, adhesions are not a contraindication but, rather, are an indication for the operation, as suggested in this and in previous articles.

It is agreed that the operation should be performed with the least possible trauma. I have long since stopped inserting the spatula and sweeping it across the chamber in the classic manner, but have insinuated its tip along the attachment of the ciliary body, slowly separating this without injury to Descemet's membrane or the adjoining parts. The handling of the spatula in this manner is similar to, and I believe the chief virtue of, the method described by Blaskovics as inverse cyclodialysis, a procedure which is advocated by Dr. Shaffer. Air injection and other modifications also appear to increase the efficacy of cyclodialysis to a considerable degree.

TRANSPLANTATION OF LACRIMAL GLANDS IN MAN AND RAT; EFFECT OF INJURY OF LACRIMAL DUCT IN RAT

Clinical and Experimental Study

MAUNO VANNAS, M.D.

HELSINKI, FINLAND

LITTLE is known about the effect of operation on the lacrimal gland, and no reports are available on transplantation of this organ, in contrast to the vast literature on surgical procedures on other parts of the lacrimal apparatus. Obviously, the subject not only is of theoretic interest but has important practical aspects. Disturbances in the secretion of tears are of two types: In one type, the eyes are dry, owing to lack of tears; in the other, there appears to be an overproduction of tears. The question whether deficient secretion can be corrected by substitution of the glandular tissue with transplants from the lacrimal glands of the second type has not been studied. With this possibility in mind, I attempted to graft the palpebral portion of the lacrimal gland from healthy persons with annoying epiphora to the eyes of patients with advanced corneal and conjunctival xerosis due to old trachoma.

REPORT OF CASES

CASE 1.—In A. V., aged 62, a laborer, the transplantation was carried out through an oblique incision in the skin near and parallel to the upper temporal margin of the orbit.[1] The tissue removed from the anterior part of the patient's gland was atrophic and tendinous. It was replaced with two thirds of the palpebral lacrimal gland from a healthy donor, a woman aged 35 with epiphora which had developed after extirpation of the lacrimal sac. The cut surface of the remaining part of the recipient's gland and that of the transplant were placed in the best possible apposition to each other. Then the small cutaneous wound was closed with two sutures, and a light pressure dressing was applied for a few days.

Histologically, the excised part of the host's gland showed only remnants of glandular structure and several incomplete excretory ducts. These residual structures were surrounded by connective tissue, fat and branches of nerves, with moderate lymphocytic infiltration and a small number of epithelioid cells and giant cells. The inflammatory changes and the destruction of the glandular tissue were probably caused by the severe trachomatous process and its complications and

This study was supported in part by the Knapp Memorial Foundation.

From the Department of Ophthalmology, Columbia University College of Physicians and Surgeons, New York.

1. I use this technic routinely in removal of the palpebral part of the lacrimal gland. A description of the method will be published in the *American Journal of Ophthalmology*.

could not be accounted for by common senile atrophy and degeneration such as was described by Radnót.[2] A slight swelling of the region of the gland two days after operation subsided in a short time under systemic penicillin therapy.

A similar transplantation was performed six weeks later on the left side. The tissue to be grafted was taken from a middle-aged woman with epiphora. A small strip of fornix conjunctivae with subconjunctival tissue, which presumably contained excretory ducts, was transferred with the glandular tissue. Hardly any inflammatory reaction was observed after the operation, in which penicillin was used locally. Subjective relief of symptoms of irritation was attributed to decrease of dryness of the eye, but these changes could not be confirmed by objective means because of the excessive xerosis. The surface of the cornea gave the impression of being clearer after the operation, but vision remained limited to counting fingers at a distance of 0.2 to 0.3 meter.

Case 2.—J. S., a teacher aged 58, was the recipient. A patient aged 40 with epiphora served as donor. A technic similar to the one described in the preceding case was employed except that the middle part of the gland was selected as the graft. Thus, the anterior and posterior poles of the lacrimal glands of both patients were kept intact and a middle portion was excised by two incisions vertical to the long axis of the gland. During this procedure a severe hemorrhage, necessitating ligation of the vessel and tamponade, occurred in the receiver's eye. The operation was completed on the following day without further complication or undue reaction. The graft prepared on the first day was stored in liquid paraffin at a refrigerator temperature of 4 C. In the weeks following the surgical intervention the patient noticed subjective improvement. Examination of the eye also revealed some beneficial effect of the treatment on the xerotic condition of the cornea. Three months later the upper half of the cornea was distinctly clearer and appeared less dry. Vision improved moderately in this period from seeing finger movements in front of the eye to counting fingers at a distance of 0.5 meter.

The results of these three attempts to transplant lacrimal tissue do not permit conclusions as to the nature of the moderate clinical improvement and of certain factors which may have influenced the outcome of the treatment. It was thought that information could be gained by experiments on animals. These I carried out in the department of ophthalmology, Columbia University College of Physicians and Surgeons.

EXPERIMENTAL STUDY: TRANSPLANTATION OF LACRIMAL GLANDS IN RATS

Adult albino rats were selected as experimental animals. The rat has two lacrimal glands on each side. Their anatomic characteristics have been described by Greene,[3] Griffith and Farris,[4] Jaffé[5] and others.

2. Radnót, M.: Die pathologische Histologie der Tränendrüse, Basel, S. Karger, 1939.

3. Greene, E. C.: Anatomy of the Rat, Transactions of the American Philosophical Society, new series, vol. 27, Philadelphia, University of Pennsylvania Press, 1935.

4. Griffith, J. Q. Jr., and Farris, E. A.: The Rat in Laboratory Investigations, Philadelphia, J. B. Lippincott Company, 1942.

5. Jaffé, R.: Anatomie und Pathologie der Spontanerkrankungen der kleinen Laboratoriumtiere: Kaninchen, Meerschweinchen, Ratte, Maus, Berlin, Julius Springer, 1931.

The large extraorbital gland is located in front of, and slightly below, the ear. From its anterodorsal border a long duct leads toward the small intraorbital gland in the dorsoposterior region of the orbit. The excretory ducts of the two glands open together in the conjunctival sac. The extraorbital part has a fine membranous capsule, whereas the gland in the orbit is covered with a dense fascia.

Technic.—The hair in the area between the eye and the ear was closely clipped off; in one-half the experiments the skin was painted with a 3 per cent solution of iodine tincture U. S. P. Ether anesthesia was preferred to the use of barbiturates. Deaths occurred several times during anesthesia because the delicate operations lasted sometimes up to three hours. After the cutaneous incision was made, cutting instruments were employed as little as possible in an attempt to avoid hemorrhage. In part of the experiments the extraorbital and intraorbital glands were exposed through separate wounds in the skin; in others both glands were reached through one incision. In several experiments the membranous or fascial cover was closed with silk or surgical gut sutures. The wound in the skin was always sutured. The condition of the eyes, and especially of the cornea and conjunctiva, was observed macroscopically and examined biomicroscopically at regular intervals during the observation period of seventy-five to ninety-nine days. After the animals were killed, the skin over the region of operation was carefully removed. Notes were made on the appearance of the glands before they were extirpated. The intraorbital gland was always excised together with the harderian gland and the eye. A fine silk suture placed on the dorsal border of the extraorbital gland served to orient the microscopic specimen and to mark the junction between the host gland and the grafted tissue. The preparations were fixed in dilute solution of formaldehyde U. S. P. (1:10), embedded in paraffin, sectioned in series and stained with hematoxylin and eosin. Forty-six transplantations were performed. They consisted of autotransplantations and homeotransplantations.

Autotransplantations.—Technic: In these operations the glands on one side, or parts of them, were exchanged for the respective glands, or parts, on the other side. The experimental procedure was repeated twelve times. In individual groups one quarter, one half or three quarters of the gland was transplanted. The lids of the right eyes were closed with one suture. The lids of the left eyes were not sutured after the operation.

Results: None of the animals operated on showed any macroscopic lesion of the eyes, and cornea and conjunctiva appeared normal on examination with the slit lamp. Autopsy revealed that the extraorbital glands of the right side were of normal, or nearly normal, size. Those on the left side were smaller or seemed atrophied. A distinct horizontal line at the upper part of one extraorbital gland presented probably the junction between the autochthonous tissue and the graft. Such a division line was even more clearly visible on the ventral surface of the preparation from the left side, indicating that the two parts of the specimen were separated by new-formed tissue. The small size of the intraorbital gland (about one-half to one-third that of the extraorbital gland) and

the fibrous adhesions with surrounding tissues made it difficult to form an opinion about the condition of the specimen.

Histologic studies of the extraorbital gland revealed in about one half the experiments a distinction between the two parts of the preparation, indicated by a layer of connective tissue along the border of the graft. Strands of connective tissue extended sometimes from the cut surface between the glandular lobules, but they were neither massive nor abundant. The surgical intervention had injurious effects of differing severity on the glandular tissue. The epithelial cells sometimes appeared shrunken, with nuclei varying in size and staining quality. These changes were not limited to the tissue of the graft but involved the host gland as well. Atrophy of glandular structures, proliferation of connective tissue and degenerative changes were most marked in the left extraorbital gland of 1 animal, in which the graft constituted 80 per cent of the preparation. Because of the size of the graft, it had been necessary to sever relatively large excretory ducts.

In intraorbital preparations, it was usually not possible to differentiate the two portions histologically, except in 1 specimen with severe structural disorganization of the transplanted part. In the other experiments the intraorbital perparations showed little damage or were well preserved, and the histologic picture was the same throughout the section. In several specimens the glandular tissue seemed divided into separate areas, and in others only small areas of glandular tissue were seen histologically.

Homeotransplantations.—Technic: Thirty-four glands were transplanted from one animal to another. Both animals were under ether anesthesia during the long and laborious procedure of exposing, dissecting and exchanging eight glands. In 3 instances the anesthesia had to be discontinued before the operation could be completed. Although it was attempted to observe sterile conditions, several infections occurred. At one time an endemic infection of the respiratory tract in the colony may have increased the incidence of local inflammation. The observation period and the range in size of the transplants were analogous to those in the previous series.

Results: The homeotransplantations differed from the autotransplantations in the greater damage to cornea and conjunctiva. In contrast to the experiments with the exchange of the glands in the same animal, the cornea and conjunctiva were considered normal in only 5 of 18 eyes. Extensive ulcers of the cornea developed in 6 eyes; occasionally the conjunctiva also showed ulcerous, granulating lesions. All these eyes had a dry appearance. The remaining 7 eyes exhibited lesions of milder character, which healed in part during the time of

observation. The course was complicated by postoperative infection in 4 instances. The cornea and conjunctiva of these animals were never normal.

To gross inspection 4 of the 18 extraorbital gland preparations were of normal size and appearance. One or two gray lines marked the margin of the transplanted part in several glands. A great number of preparations looked atrophic, and some were reduced to a size of about 2 by 2 mm. In 1 rat the extraorbital gland had completely disappeared; the graft in this animal was taken two hours after the death of the donor and was transplanted in a very dry condition. Except in 1 instance, the postoperative infections mentioned had caused great damage to the glandular tissue. The condition of the intraorbital glands could not be evaluated grossly because they were excised with adjacent orbital tissues.

In 5 transplantations of extraorbital glands it was possible to distinguish histologically the two portions of the preparation. The fact that this distinction could not be made in other experiments did not necessarily indicate a failure of the grafting. The way in which some of the preparations were sectioned and artificial separation of parts of the specimen also accounted for the difficulty in differentiating the graft from the host tissue.

Loeb[6] classified the results of transplantations of thyroid gland by the amount of lymphocytic infiltration, the ingrowth of connective tissue and the invasion by fat tissue. In the most successful operations the initial lymphocytic infiltration disappeared, formation of connective tissue was minimal and fat tissue was absent. In another group, the graft tissue was well preserved, but the thyroid of the host showed round cell infiltration of varying degrees and connective tissue was more abundant. In the least favorable group Loeb listed experiments in which the transplanted tissue was more or less destroyed and fibrous tissue had invaded the host gland or had replaced it completely.

Three of the 18 extraorbital glands in the present series seemed to belong to Loeb's first group. In some parts of the specimen no connective tissue had developed between the two portions, and no round cell infiltration was seen. The suture marking the junction of the two parts of the preparation was usually well visible. The results of 4 grafting operations were similar to those in Loeb's second group. The rest of the transplantations, in which the course was unfavorable, belonged to the third group. The transplants showed the histologic signs described by Loeb in unsuccessful transplantations of the thyroid gland. Preparations from rats with postoperative infections also had

6. Loeb, L.: The Biological Basis of Individuality, Springfield, Ill., Charles C Thomas, Publisher, 1944.

to be included in this group. In general, there was agreement between the macroscopic appearance and the histologic picture in this experimental series.

It was more difficult to judge and to grade the transplantations of the intraorbital glands. The small size of the gland, the dense fibrous cover and the impossibility of immobilizing the portion of the gland after grafting were the reasons that cut surfaces could not be placed in good apposition to each other or kept in a suitable position. Histologic examination revealed that only 2 of 12 transplantations were relatively satisfactory, but even in 1 of these 2 transplants the lymphocytic infiltration was considerable. The visible parts of other intraorbital glands were well preserved, but it was not clear which portion belonged to the graft and which to the host gland. Because of the small size of the preparation, marking sutures usually could not be inserted at the proper place; this procedure could be carried out only in 1 experiment.

INFLUENCE OF EXTIRPATION OF THE LACRIMAL GLAND AND OF INJURIES TO ITS EXCRETORY DUCT IN RAT EYES

It has been suggested in the first series of experiments that the effect of the operation on the cornea and conjunctiva was more deleterious when in the transplantation large excretory ducts had to be severed, as, for instance, in the exchange of a portion of the lower part of the extraorbital gland. This impression was confirmed in histologic studies of the preparations. Furthermore, it was soon noticed that any surgical procedure on the rat gland held more potential risks than a similar operation on the human lacrimal gland. While the properly executed extirpation of the palpebral lacrimal gland rarely causes serious complication in the human eye, surgical procedures of even minor character on the glands of rats were often injurious to the surface of the globe. The anatomic description of the rat lacrimal glands indicated the great species differences of these organs. The mass of the two lacrimal glands in the rat exceeds that of the human gland on the basis of the comparison of the glands with the size of the globe. In contrast to the condition in the rat, in man accessory glands can take over a part of the function of the lacrimal gland. Some of the unexpected postoperative reactions in the present experimental series seemed to be related to the species differences. The most important observation in the reported experiments was the decisive part played by the type of dissection used in the grafting. The placing of the severing incision influenced the outcome of the experiment more than the size of the transplanted portion of the gland. On the basis of this observation, further studies were carried out by simply excising the gland and severing the excretory duct or removing a part of it.

Extraorbital and intraorbital lacrimal glands were excised from the right eye of 3 rats; the extraorbital gland alone was excised in 1 rat. The lids on the side of operation were closed with one silk suture, which was anchored only in the skin. The sutures fell out within three to fourteen days. The left eyes, serving as controls, were not touched; they remained normal during the observation period of about eighty days.

Severe lesions of the cornea and conjunctiva were observed in all animals in which both glands had been extirpated. They were noted as soon as the sutures had fallen out. Large ulcers or granulating surfaces were seen on the cornea and on the bulbar conjunctiva, resulting in scar formation with xerotic changes. The corneal opacities were often so dense that the iris was not visible. Extirpation of the extraorbital gland alone resulted in similar, but less severe, lesions in the anterior part of the eye.

The operation on the lacrimal excretory ducts consisted (1) in cutting the duct between the extraorbital and the intraorbital gland (6 eyes); (2) in severing the duct after it had passed through the intraorbital gland (4 eyes), and (3) in excising a portion of the duct between the two glands (3 eyes). In the last operation it was necessary to examine the excised tissue histologically to prove that duct tissue had been removed. This control examination could not be applied to experiments with simple sections through the duct.

The simple cutting of the duct of 6 extraorbital glands was followed by only slight changes in the cornea or conjunctiva during the observation time of forty-seven to eighty days. At the termination of the experiments the exposed extraorbital glands did not differ greatly from the appearance of normal glands, but microscopically 2 glands showed severe degenerative changes. Histologic sections of the 4 remaining glands revealed either moderate changes or a normal appearance. The intraorbital glands of these animals did not present any major lesion.

The section of the duct after it emerged from the intraorbital gland was often complicated by an unavoidable injury to the intraorbial gland. Large ulcers and granulating defects in the cornea and conjunctiva were observed in 2 eyes. Minor lesions were seen in the other 2 eyes of the short series. Macroscopically, 3 intraorbital glands were reduced considerably in size, and 1 was slightly smaller than normal. The histologic picture of these preparations also reflected the severity of the pathologic changes. Similar damage was noticed in the section of 2 intraorbital glands. The small remnants of glandular tissue in the other 2 specimens did not permit histologic evaluation.

The section of the duct of the extraorbital gland consisted in 2 instances in the removal of a piece 3 mm. in length, and in 1, in the excision of the whole duct between the surface of the extraorbital gland and the orbit. Histologic examination showed the duct as it entered

the intraorbital gland and as it emerged from the gland. In these 3 specimens the damage to both the extraorbital and the intraorbital gland exceeded the injurious effect of any other surgical procedure reported in this study. Surprisingly, the cornea and conjunctiva of 2 eyes did not show major lesions; only in experiments with total extirpation of the duct did the surface of the globe show extensive ulcerations. Therefore the clinical and histologic changes in the eyes and glands seemed to depend on the length of the excised piece of duct and were minimal in eyes with simple severing of this structure. Furthermore, the lesions in these less involved eyes showed a tendency to heal as time went on, and the microscopic changes in the lacrimal glands were relatively moderate.

COMMENT

Limited experience with partial transplantation of human lacrimal glands to patients with xerophthalmos encouraged grafting of lacrimal gland tissues in rats under controlled experimental conditions. The results in the 46 autotransplantations and homeotransplantations indicated that the exchange of parts of lacrimal glands in the same animal from one side to the other was far better tolerated than was homeotransplantation. Microscopic and histologic changes and the character of ulcerative processes in the cornea and conjunctiva substantiated this impression. The outcome of the surgical procedures, including the injurious effect on the eye, seemed to depend on the type of dissection of the glands, i. e., on whether or not large ducts were cut, rather, than on the size of the grafted portion of the gland tissue. This observation would point to the advisability of obtaining grafts from longitudinal dissections, in which the continuity of the excretory ducts would be preserved as much as possible.

The small number of successful transplantations in this experimental series should not discourage further studies on the problem. As the recent progress in keratoplasty has been linked to the improvement of the surgical technic, advances in and perfection of the delicate operative procedure may also influence beneficially the results of transplantation of lacrimal gland tissue. The suitable anatomic and functional relation of the lacrimal glands to the eyes of rats led to preliminary studies on the effects of simple extirpation of the gland and of severing and excision of the lacrimal excretory duct in this experimental animal. The results suggested that severed ducts may reunite, and possibly regenerate.

SUMMARY

Partial transplantation of tissue of the normal palpebral lacrimal gland from a patient with epiphora to a patient with severe xerophthalmos was of moderate benefit in 1 of 3 eyes.

In contrast to the human eye, surgical grafting of lacrimal gland of the rat led often to severe complications in the eye.

The large lacrimal glands of rats were used for autotransplantations and homeotransplantations. Autotransplantations were less injurious to the sensitive rat eye than were homeotransplantations. The latter also caused more pathologic changes in the gland than the exchange of gland tissue in the same animal.

Experimental results suggested that injury to the excretory duct in the grafting procedure is mainly responsible for the deleterious effect of the operation.

The relatively small number of successful transplantations may be due to imperfections in the technic.

Preliminary experiments on simple section and of excision of the excretory duct may be interpreted as suggesting a moderate regenerability of the structure in this experimental animal.

INFLUENCE OF CERTAIN MYDRIATICS ON THE ASCORBIC ACID CONTENT OF THE AQUEOUS HUMOR

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THEORIES to explain the occurrence of hyphema following cataract extraction have suggested a low ascorbic acid content, trauma from the dressing of the eye, blepharospasm, rupture of the new-formed capillaries of the wound and hemorrhage from an iridectomy. The usually accepted explanation of postoperative hemorrhage is rupture of new-formed capillaries in the healing wound. The fact that these hemorrhages often occur at night on the third or fourth postoperative day, when the least trauma is being exerted, and often in the most cooperative and placid patients, does not make this explanation of the hyphema entirely satisfactory.

Hyphema rarely occurs if a preliminary iridectomy has been done. The incidence in several published series is reduced from 10 or 12 to 2 or 3 per cent if a preliminary iridectomy has been performed. Yet the wound healing and the rupture of the capillaries in these wounds would be comparable if no iridectomy or previous surgical work had been done. Corneal section and the use of corneoscleral sutures have reduced the incidence of hyphema, but the complication is still too frequent to be attributed solely to trauma.

In a few instances in which repeated hyphema has occurred after the patient was discharged from the hospital, the discovery of an inadequate ascorbic acid level in the blood influenced ophthalmologists to use large doses of ascorbic acid both before and after operation to aid in wound healing and to prevent hyphema. The incidence of hyphema is higher after intracapsular extraction than after extracapsular extraction. The complete depletion of the ascorbic acid content of the lens, as well as of the aqueous, in the intracapsular extraction suggested to us that some factor other than rupture of the wound capillaries is needed to explain the occurrence of hyphema.

This work made possible by a grant from the South Bend Medical Foundation.

DeVoe's [1] investigation of the ascorbic acid levels of the blood of 136 cataractous patients in their relation to postoperative hyphema showed that if the levels were low hemorrhages were more apt to occur, but that hemorrhages also occurred in some patients with high ascorbic acid levels. Franta [2] pointed out that the ascorbic acid content of the aqueous of cataractous patients was lower than that of normal patients without cataract. Gapeev [3] gave figures of 7.7 to 15.8 mg. per hundred cubic centimeters of ascorbic acid in the aqueous of normal eyes, and of 2.8 to 7.4 mg. per hundred cubic centimeters of ascorbic acid in the aqueous of cataractous eyes. The ascorbic acid content of the blood was from 0.3 to 1.2 mg. per hundred cubic centimeters for patients with normal eyes, whereas it was 0.08 to 0.46 mg. for the cataractous patients.

Some hyphemas following cataract extraction may be attributed to low ascorbic acid levels, and most ophthalmologists use large doses of ascorbic acid to prevent spontaneous hemorrhage. The tendency to use atropine or some other mydriatic on the third day to move the round pupil and the appearance of hyphema at about this time suggested that there might be some relation between the mydriatic and the hyphema.

The ascorbic acid content of the aqueous and of the lens is ten to twelve times that of the blood, but the ascorbic acid content of the secondary (plasmoid) aqueous is very low, a fact which may account for the radical change in the ascorbic acid content of the aqueous after a cataract is extracted.

The ascorbic acid content of the cataractous lens is progressively reduced as the lens becomes more opaque, until with complete opacification it is very low. Since we have been removing the cataract before it is ripe, and when much of the lens is clear, an intracapsular, rather than an extracapsular, extraction has been done. The increase in the incidence of hyphema after intracapsular extraction, as compared with that after extracapsular extraction, may be due to the sudden depletion of the ascorbic acid content of the eye. In extracapsular extraction, the nucleus of the lens is removed but some cortex remains, and this has moderate reducing power for the production of ascorbic acid. In the intracapsular extraction, however, there is a sudden loss of all such function, as well as of the whole ascorbic acid content of the lens and aqueous.

1. DeVoe, G.: Hemorrhage After Cataract Extraction: Clinical and Experimental Investigation of Its Cause and Treatment, Arch. Ophth. **28**:1069-1096 (Dec.) 1942.

2. Franta, J.: Die Askorbinsäure (Vitamin C) in Metabolismus des Kammerwassers, Arch. f. Augenh. **110**:574-609 (Nov.) 1937.

3. Gapeev, P. I.: Ascorbic Acid Content of Aqueous Humor, Crystalline Lens and Blood in Cataract Patients and in Normal Persons, Vestnik oftal. **18**:154-160, 1941; abstracted, Am. J. Ophth. **24**:1466 (Dec.) 1941 and Arch. Ophth. **27**:1219-1220 (June) 1942.

Moreu [4] (1) pointed out that atropine instilled into the eye resulted in almost complete disappearance of ascorbic acid from the eye; (2) warned against employing mydriatics before operation, especially those which have a paralyzing effect on the parasympathetic system, and (3) cautioned against instillation of atropine-like drugs until ten days after operation. He pointed out that instillation of acetylcholine or carbachol (doryl®) stimulated the parasympathetic system and was accompanied with the formation of ascorbic acid in the aqueous, but that atropine instilled into the eye paralyzes the parasympathetic nerve endings and results in almost complete disappearance of ascorbic acid, both in the oxidized and in the reduced form.

The fact that hyphema occurs oftener when the ascorbic acid levels are low, that it takes place on about the third or fourth day after mydriasis is first induced (use of atropine-like drugs) and that it is more frequent after intracapsular extraction (when all of the ascorbic acid is removed) makes it seem feasible to inquire into the effect of atropine-like drugs on the ascorbic acid content of the eye. Hence, the effect of instillations of atropine on the ascorbic acid content of the rabbit aqueous was investigated.

PRESENT STUDY

Method and Material.—Ascorbic acid determinations were made using a variation of the method developed by Roe and Kuether,[5] which depended on the production of a reddish condensation product by the treatment of dehydroascorbic acid with 85 per cent sulfuric acid solution of 2, 4-dinitrophenylhydrazine. With the use of copper sulfate, the method was adapted to the determination of both the reduced and the oxidized form of ascorbic acid, as was done by Bessey and associates.[6]

Experiments were carried out on young rabbits of various breeds. After a period during which the right eye was given occasional drop-sized instillations of either an ophthalmic ointment containing 1 per cent atropine sulfate or a 1 per cent aqueous solution of paredrine® hydrobromide (a 1 per cent solution of the hydrobromide of *p*-[2-aminopropyl] phenol in distilled water) aqueous humor was removed from both eyes and its ascorbic acid content determined. The ascorbic acid content of the left eye served as a control in the determination of changes that had occurred in the ascorbic acid content of the right eye. The experimental data are given in table 1. In order to determine the possible effect of traces of the drug on the accuracy of the analytic method for ascorbic acid in

4. Moreu, A.: El hifema post operatorio en la extracción del cristalino, Arch. Soc. oftal. hispano-am. **5**:467-471 (June) 1945.

5. Roe, J. H., and Kuether, C. A.: The Determination of Ascorbic Acid in Whole Blood and Urine Through the 2, 4-Dinitrophenylhydrazine Derivative of Dehydroascorbic Acid, J. Biol. Chem. **147**:399-407 (Feb.) 1943.

6. Bessey, O. A.; Lowry, O. H., and Brock, M. J.: The Quantitative Determination of Ascorbic Acid in Small Amounts of White Blood Cells and Platelets, J. Biol. Chem. **168**:197-205 (April) 1947.

TABLE 1.—*Experimental Determinations of Ascorbic Acid Content of Aqueous of Rabbit Eyes After Instillation of Atropine-Like Drugs*

Rabbit No.	Eye	Drug Used	Time of Instillations Previous to Sampling of Aqueous Humor, Hr.	Ascorbic Acid Content: Oxidized Form (Mg./100 Cc.)	Ascorbic Acid Content: Reduced Form (Mg./100 Cc.)	Ascorbic Acid Content: Percentage Oxidized Form of Total Content	Percentage Change in Total Ascorbic Acid Content
6	Right	Atropine	19½, 18, 16½, 2, 1	0	16.8	0	+10
6	Left	None	.....	0	15.3	0	....
7	Right	Atropine	19½, 18, 16½, 2, 1	0	21.6	0	+11
7	Left	None	.....	0	19.5	0	....
9	Right	Paredrine	17, 2, 1½, 1, ½	0.8	18.4	4.0	—5
9	Left	None	.....	1.1	18.6	5.6	....
11	Right	Paredrine	17½, 16½, 2, 1½, 1	0.2	10.6	2.0	—13
11	Left	None	.....	1.1	17.4	6.0	....
21	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	1.8	18.0	9.1	—8
21	Left	None	.....	2.2	19.3	10.2	....
20	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	1.9	14.5	11.6	0
25	Left	None	.....	1.3	15.0	8.0	....
23	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	2.7	23.1	10.5	+10
29	Left	None	.....	2.7	20.8	11.1	....
24	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	1.3	11.1	10.5	+10
24	Left	None	.....	0.5	10.3	4.6	....
15	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	0.6	16.7	3.5	—8
30	Left	None	.....	1.8	17.0	9.6	....
26	Right	Atropine	119, 117, 112, 96, 93, 90, 73, 70, 67, 64, 48, 43, 40, 25, 21, 17	0.8	12.4	6.1	—6
16	Left	None	.....	1.2	12.3	8.6	....

TABLE 2.—*Ascorbic Acid Content*

Substance Analyzed	Drug Added	Oxidized Form (Mg. %)	Reduced Form (Mg. %)	Percentage Change in Total Ascorbic Acid Content
Urine*	.....	0.0	5.6	....
Urine	Atropine	0.0	7.8	+39
Urine	Paredrinet hydrobromide	0.0	6.0	+7
Urine + 50 mg./100 cc. ascorbic acid supplement	.....	0.0	58.5	....
Urine + 50 mg./100 cc. ascorbic acid supplement	Atropine	0.0	57.5	—2
Urine + 50 mg./100 cc. ascorbic acid supplement	Paredrinet hydrobromide	0.0	56.3	—4
50 mg./100 cc. ascorbic acid standard	.....	0.0	50.0	....
50 mg./100 cc. ascorbic acid standard	Atropine	0.0	50.5	+1
50 mg./100 cc. ascorbic acid standard	Paredrinet hydrobromide	0.0	48.9	—2

* A fresh specimen of human urine was used.

† Registered trademark.

vitro, experiments were conducted in which the ascorbic acid content of urine was determined with and without addition of the two drugs used in the experiment. These experimental data are presented in table 2.

Comment.—The data presented allow the conclusion that, within the limits of the accuracy of the procedure used, no significant change in the total ascorbic acid content of the aqueous of the rabbit eye is caused by the use of atropine sulfate or paredrine® hydrobromide. Also, no significant change in the relative amounts of the reduced and the oxidized forms of the vitamin was observed. In vitro experiments using fresh human urine with a rather high concentration of the drugs showed no significant direct effect of the drugs on the accuracy of the analytic method.

SUMMARY

From these data, it should be assumed that Moreu's contention that the ascorbic acid content of the eye is appreciably influenced by atropine-like drugs is fallacious. At least in the rabbit eye, the instillation of atropine into the normal eye did not affect the quantity of ascorbic acid in either the reduced or the oxidized form.

The admonition to avoid the use of atropine-like drugs before and after operation, as an inciter of hyphema, at least with respect to their ascorbic acid–reducing effect, seems unwarranted.

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FAMILIAL PTOSIS OF THE EYELIDS APPEARING IN MIDDLE LIFE

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FAMILY groups have been reported[1] in whose members ptosis of the eyelids appeared at birth as a mendelian dominant trait. The present report is concerned with a family group in which ptosis developed in certain members, also as a mendelian dominant trait, only after the eyelids had been normal until 40 years of age.

The earliest known affected member (*1*, fig. 1) was born in the 1840's, had normal eyelids within the memory of some living members of the family and first noted drooping of the lids at about the age of 40, the ptosis increasing in degree until his death, at the age of 70, when he was virtually blind. It is stated that he could lift his lids only a mere bit. Four of his 7 children had ptosis of the eyelids in later life.

Member *15*, a granddaughter of *1*, was 68 years of age. In 1910 her eyes showed no abnormalities (fig. 2 *A*). About 1925 drooping was noted, and this progressed to a point at which the lids could clear the pupil only with strong effort and the aid of the frontalis muscle (fig. 2 *B*). When the examiner's thumb was pressed over the eyebrow, inhibiting the action of the frontalis muscle, there was no elevation of the lid. There was permanent and heavy transverse furrowing of the forehead; the brows remained elevated even during sleep, and the lids were thin and blue veined. The patient could see objects directly in front only by tilting the head backward. Photophobia was prominent, presumably due to her living in semidarkness most of the time.

Action of the extraocular muscles was normal (fig. 3), and the pupils reacted well to light and in accommodation. The consensual reflex was normal. The fundi showed sclerosis grade 1; the disks were normal, and no retinopathy was present. The patient's reading was limited, owing to fatigue of the neck muscles. Vision was 20/30 in each eye with corrective lenses. There was associated hypertensive heart disease of mild nature with good functional capacity. A reactive depression as a result of the ophthalmic problem had not required intensive treatment.

1. Briggs, H. H.: Hereditary Congenital Ptosis, with Report of 64 cases Conforming to the Mendelian Rule of Dominance, Tr. Am. Ophth. Soc. **16**:255, 1918.

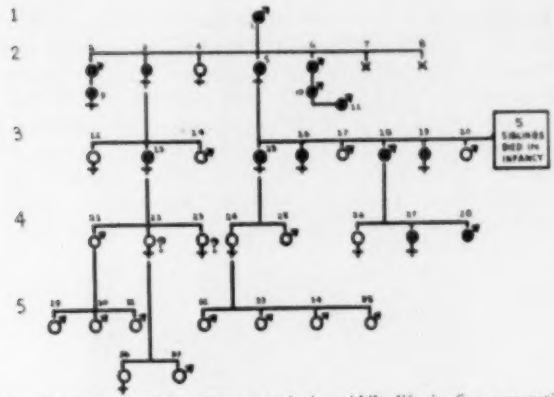

Fig. 1.—Appearance of hereditary ptosis in middle life in five generations of the same family.

Fig. 2.—Member *15*: *A*, in 1910, before the appearance of ptosis; *B*, after the development of ptosis.

The siblings of *15* (members *16*, *18* and *19*) are shown in their late thirties (fig. 4). The patient in *A* showed early weakening of the lids; death occurred from other causes in a few years. The members in *B* and *C* had almost complete ptosis in their later years; 1 of them underwent several unsuccessful surgical procedures for correction of the ptosis. I know the other members of this family to be normal.

Member *24*, daughter of *15* (fig. 5) was 42 at the time of this report and showed the drooping of the lids which older members of the family predicted would progress to full ptosis.

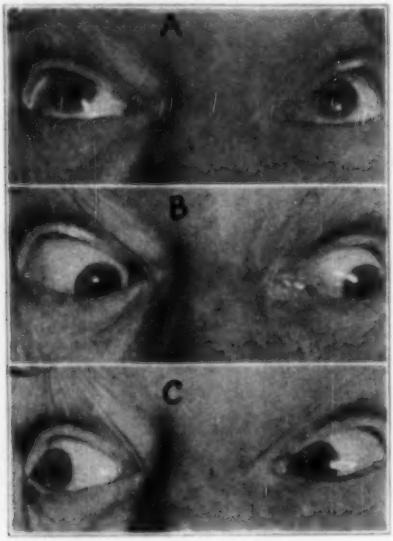

Fig. 3.—Normal action of the extraocular muscles in member *15*.

Member *13* was under my care for several years for hypertensive and coronary heart disease with intraventricular block, to which she eventually succumbed. Her ptosis was extreme and appeared in her middle forties. Pictorial evidence of this was obtained, but permission to reproduce the photographs was not granted. The width of the palpebral fissure with forced action of the frontalis muscle was 7 mm. The daughters of *13* (members *22* and *23*), now in their late thirties, are beginning to exhibit the trait.

There was no other neurologic or muscular disease in any of the members, either affected or unaffected. No positive serologic reactions were observed. Attempts to alter the degree of ptosis with quinine and

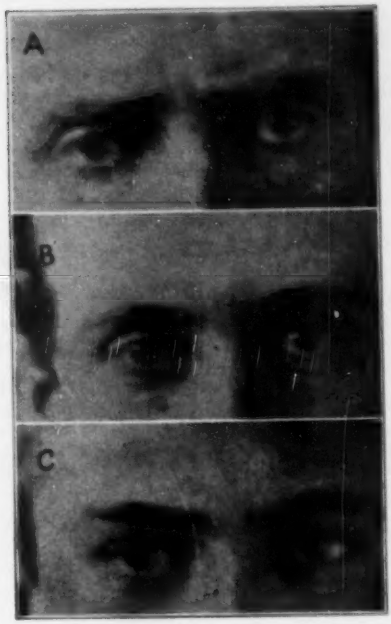

Fig. 4.—Siblings of member *15*, in their late thirties.

Fig. 5.—Member *24*, daughter of member *15*, at the age of 42.

neostigmine failed. Ephedrine did not affect the ptosis, nor did potassium. Fasciculations were not seen or described. There was no history of periodic paralysis. The jaw-winking movements were not present.

The pathologic process would appear to be a progressive degeneration of the levator palpebrae superioris muscle. There was no disturbance in the innervation to the superior rectus muscle or in any other cranial nerve. The pathologic picture in other cases has been described by Fuchs.[2]

The trait appears to show mendelian dominance. In the family studied, no generation was skipped; no affected member had an unaffected parent, and some of the children of an affected person revealed the trait. There was no sex predilection. As a point of curiosity, an attempt to determine relation to the group described by Briggs[1] was made, without success.

SUMMARY

A family group is presented in which ptosis of the eyelids appeared only in middle life, as a mendelian dominant trait. No record of a similar nature has been found.

The evidence for the late appearance of the ptosis is based on the unanimous opinion of all the members of the families contacted. Patient *15* supplied the old photographs, and 9 of the members of this family, all of generations 3 and 4, are my patients. I also know all the members of generation 5, none of them being over 26 years of age. The senior members of the family state that they can predict who will be affected later. It will be interesting to determine whether their predictions are correct.

10 South Vann Street.

2. Fuchs, E.: Ueber isolierte doppelseitige Ptosis, Arch. f. Ophth. **36**:234, 1890.

FUNCTIONAL UNILATERAL MYDRIASIS

Report of Three Cases

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THE PUPILLARY PATHWAYS

THE ANOMALIES of the pupillary pathways are manifold and intricate. Since it is a truism that to understand better the abnormal, one must know the normal, it would seem proper to review briefly a few salient points concerning these pathways.

The size and action of the pupils are determined by the local state of the iris itself, the chemical events occurring at the myoneural junctions, the balance of neural stimuli flowing through the sympathetic and parasympathetic systems and the person's general emotional state. Of greatest importance concerning the local state of the iris is the condition of its blood vessels, relaxation (congestion or sclerosis) of the vessels resulting in miosis and constriction in mydriasis. Although all these factors seem at first glance somewhat distinct, they are so closely interrelated that it is only in unusual circumstances that one can determine their individuality.

The normal pupillary diameter is stated to be between 2.5 and 4 mm., with an average of 3.5 mm., which for optical reasons appears to the observer as 4 mm. When it is increased beyond 5 mm., one certainly may state that mydriasis exists. In general terms, pathologic mydriasis may be due to the action of adrenergic drugs, to pathologic conditions within the eyeball, to lesions in the efferent pupillary pathways or centers in the midbrain—either a paretic lesion of the constrictor mechanism or an irritative lesion of the sympathetic nerve supply—or to cerebral events acting mainly by inhibition of the constrictor center. Pathologic miosis may be due to the action of cholinergic drugs, to pathologic conditions within the eyeball, to lesions in the efferent pupillary pathways or the centers of the midbrain—either an irritative lesion of the constrictor mechanism or a paretic lesion of the sympathetic mechanism—and, much more rarely, to cerebral events which remove inhibitory influences from the constrictor center in the midbrain.

The most important factors controlling the size and action of the pupils are the result of the algebraic sum of the two physiologically antagonistic systems which control its activity—the parasympathetic

(cholinergic) and the sympathetic (adrenergic). It would appear that, of the two, the first is the active, being activated centrally by rhythmic discharges both of excitation and of inhibition. The role of the sympathetic system is essentially the maintenance of a constant state of tone in the dilator muscle to supplement the effect of relaxation of the sphincter, and its dilator action alone, without the constrictor center, but exerted directly, is minor and less effective.

Represented diagrammatically (figs. 1 and 2, modified from Duke-Elder[1]) are the parasympathetic and sympathetic pupillary pathways. From these diagrams it is apparent that the primary action of

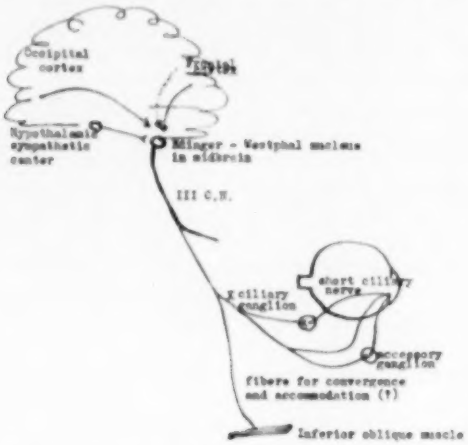

Fig. 1.—The parasympathetic pupillary system (modified after Duke-Elder[1]). Inhibition, producing dilation, is indicated by broken lines; excitation, producing miosis, by solid lines.

Stimulation of the cortex results in inhibition or excitation of the constrictor center, depending on the area stimulated. The sympathetic center in the hypothalamus constantly inhibits the constrictor center, but it might also be under cortical influence.

From the Edinger-Westphal nucleus, the pathway is via the third nerve and then via the fibers (*a*) to the inferior oblique muscle; (*b*) for the light reflex, to the ciliary ganglion and from there in the constrictor fibers of the short ciliary nerves to the sphincter of the iris, and (*c*) for the near reflex, to the accessory ganglion and then to the iris or to the iris directly or to both.

X marks the area of the probable site of the lesion in the present cases.

the sympathetic nervous system is inhibition of the constrictor mechanism; but it is likewise evident that it can act independently.

1. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1949, vol. 4, pp. 3731-3806.

THE PUPILLARY REFLEXES

Clinically, there are three important types of pupillary reflexes: (1) those due to lights; (2) those accompanying associated reflexes (convergence; accommodation; orbicularis [eyelid reflex, Westphal-Piltz phenomenon]) and (3) the psychosensory and the visuocortical, which are of little clinical significance. The first two types consist in constriction of the pupil, and the third, in dilation; and the state of the pupil represents the balance of the interplay of these reflexes.

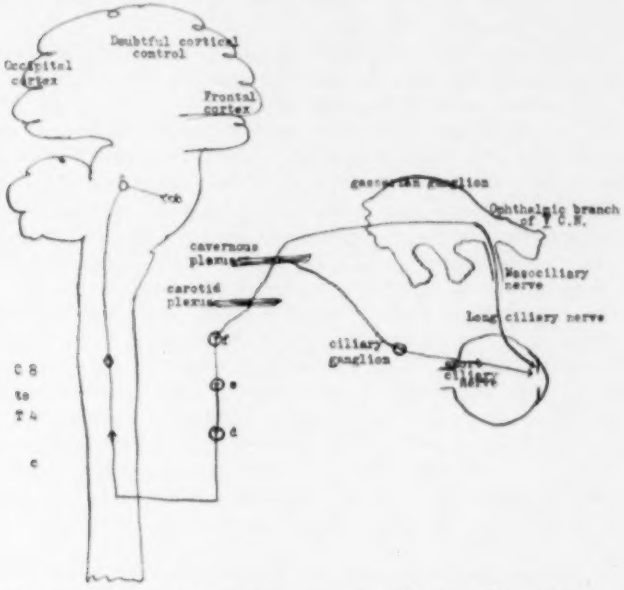

Fig. 2.—The sympathetic pupillary system (modified after Duke-Elder[1]).

(*a*) Hypothalamic sympathetic center; (*b*) Edinger-Westphal nucleus of the third cranial nerve; (*c*) ciliospinal center of Budge with partial decussation above; (*d*) inferior cervical ganglion; (*e*) middle cervical ganglion above the annulus of Vieussens; (*f*) superior cervical ganglion.

Note that the short ciliary nerves carry both pupillodilator and pupilloconstrictor fibers (fig. 1).

The pathway for the light reflex is now believed to be fairly well outlined. The pupillary fibers pass in the optic nerve and the tract, then leave the latter to traverse the medial border of both geniculate bodies, enter the brachium quadrigeminus, pass toward but do not enter the superior colliculus and pass rostrally and medially into the

pretectal region to find their first relay station in the pretectal nucleus, a circumscribed oval group of cells situated at the dorsal surface of the tectothalamic junction. Thence impulses are relayed by fibers which mostly cross in the posterior commissure and pass close to or traverse the central gray matter around the aqueduct to reach the Edinger-Westphal division of the oculomotor group of nuclei of the opposite side; some fibers from the pretectal nucleus, however, pass to the ipsilateral constrictor nucleus. Perlia's nucleus of convergence is connected with both Edinger-Westphal nuclei and is centrally located. The efferent fibers pass by way of the third nerve, thence to the ciliary ganglion and thence to the muscles of the iris.

Little is known about the dilator reflex to darkness, but it is believed that the afferent path is via the optic tract into the midbrain, thence to the cord, where there may be a partial decussation, thence to the cilio-spinal center of Budge, thence to the superior cervical ganglion and then over the usual sympathetic nerve route. These fibers leave those mediating the light reflex near the brachium of the superior colliculus.

The near reflex is made up of two components: the convergence reflex, stimulated by the movement of convergence, the nerve pathway of which has no connection with the visual pathways but is limited to the midbrain, and the accommodation reflex, stimulated by the blurred images of near objects, the path for which travels up the optic pathways to the occipital cortex, whence it is relayed down to the constrictor center in the midbrain. Both are illustrated simply (fig. 3). The convergence reflex is activated by proprioceptive impulses in the internal rectus muscles, but from here the path is not known. Some believe that a branch of the fifth cranial nerve receives these impulses and relays them. Eventually, they reach Perlia's nucleus and pass thence to the Edinger-Westphal nucleus. The accommodation reflex is activated in the retina, and the fibers go via the visual pathways to the calcarine cortex (area 17) and from there to the peristriate area (area 19). From here the impulses go to Perlia's nucleus and thence to the Edinger-Westphal nucleus. From this nucleus the efferent path common to the two reflexes passes down the oculomotor nerve for an unknown distance, leaves it proximal to the ciliary ganglion and relays possibly in an accessory ganglion, from which postganglionic fibers reach the constrictor pupillae.

Of the two parts of the near reflex, that for convergence is the more potent and after orbital injuries has proved more viable than the light reflex; in such a condition the usually dilated pupil on the affected side does not react to light either directly or consensually (efferent pathway involved), and both pupils react normally in accommodation and convergence. Such evidence supports the theory that the fibers for the

near reflex are distinct from those for the light reflex, with a relay either in the accessory episcleral ganglion of Axenfeld or in ganglionic elements in the iris itself or in both. It must, however, be remembered that the two elements of the near reflex may be dissociated either physiologically or pathologically.

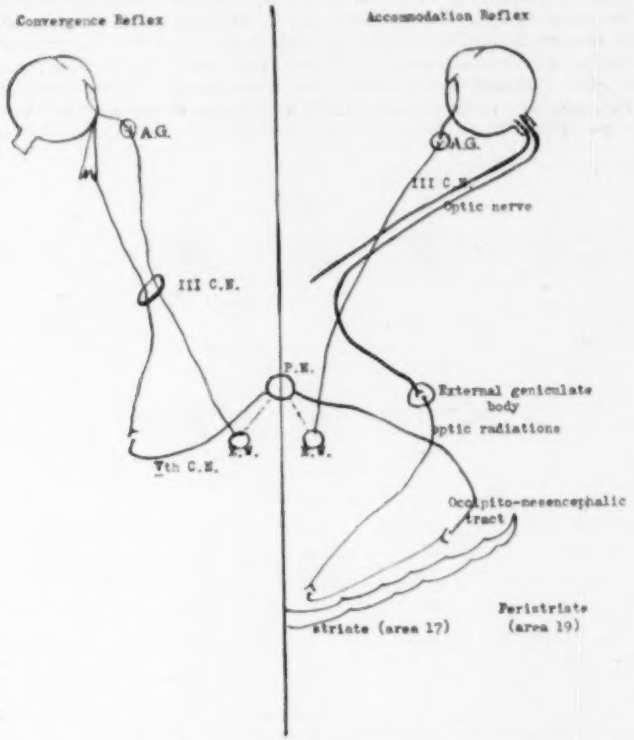

Fig. 3.—The near reflex (modified after Duke-Elder [1]). *E.W.* indicates the Edinger-Westphal nucleus; *P.N.*, Perlia's nucleus; *A.G.*, the accessory ganglion. Fibers may go directly to the iris without relay in the accessory ganglion.

This brief review of some of the less complicated aspects of the pupillary pathways will prove helpful in the discussion of the 3 cases that follows.

REPORT OF CASES

Three drops do not an ocean make, nor do 3 cases constitute a syndrome. Certainly, the 3 cases here reported do not represent a completely new phenomenon, but are variants of a similar type reported often

in the past; since they have common features, however, they will be recorded as a group.

The 3 patients were all white, married, nonpregnant women, aged 24, 27 and 32, respectively. All were happily married; none seemed frustrated or appeared to have psychoneurotic manifestations, and all were myopic and had not worn glasses for at least four months before they were seen, except on rare occasions. The myopic spherical equivalents were —3.25, —4.25 and —3.75 D., respectively. All the patients were right handed and right eyed. All recovered within forty-eight hours. All were in good general health and the results of all studies, except for those given here, were normal. These studies included the usual laboratory procedures, as well as roentgenographic examination of the skull and studies of the spinal fluid. The history was without significance except for some

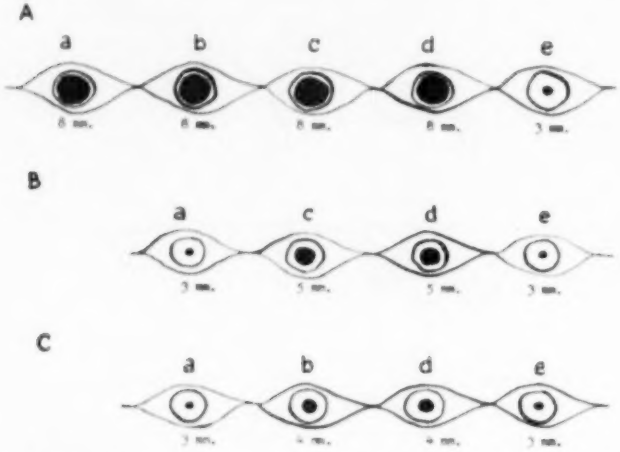

Fig. 4.—Pupillary reactions of the right eye to various drugs. *A* (mydriatic type) shows immediate reactions; *B* (normal pupil), reactions forty-eight hours later, and *C* (normal pupil), reactions twenty-four hours later. In these diagrams, the pupil is shown (*a*) at rest, (*b*) after instillation of epinephrine hydrochloride (1:1,000), (*c*) after instillation of 4 per cent cocaine, (*d*) after instillation of 20 per cent methacholine hydrochloride and (*e*) after instillation of 1 per cent physostigmine salicylate.

disturbance of vision in the right eye in each case, followed by the observation on the part of the patient that the pupil of that eye was enlarged. The mydriasis was relatively abrupt in onset. One patient did not even say much about her visual disturbance but stated that a friend had called her attention to the mydriasis. When I saw the patients, there was nothing unusual other than unilateral mydriasis. There was no widening of the palpebral fissure, exophthalmos or sympathetic or other vasomotor phenomenon; the tendon and other reflexes were normal, and vision and accommodation were unaffected. The patients had some visual disturbances due to the mydriasis, but visual acuity was

normal for near and far with corrective lenses. The pupils, however, were immobile to light and in accommodation; in convergence, however, there was some reaction, but this was slight. The Piltz-Westphal (orbicularis) phenomenon was not present in any of the eyes affected. The afferent pupillary pathway in all 3 eyes was intact, but no consensual reaction in these eyes could be elicited. Since it was assumed that the disturbance was a functional mydriasis of unknown origin involving the efferent constrictor pathways, related somewhat to the Adie syndrome, pupillary studies were undertaken. The chart reveals the results of these studies (fig. 4). It should be mentioned that one of the patients was not given physostigmine at first, but, as with the others, in two days recovery was complete without any therapy, unless instillation of the pupillary diagnostic drugs can be considered therapy. The pupillary reflexes were not changed in the two eyes treated with physostigmine when the patients were first seen, and these pupils slowly dilated to their original state within the next eight hours. The patients were not taking drugs, and accidental contamination was ruled out, even though one of the patients was a registered nurse.

The patients all volunteered the information that their eyes became normal about thirty-six hours after I had seen them. Forty-eight hours later the eyes appeared normal by my tests. The pupillary studies then revealed the reactions, as charted. In another twenty-four hours, Loewi tests elicited pupillary dilation in all eyes, an interesting observation since cocaine still dilated these eyes and methacholine (mecholyl®) had no effect. At this visit, neither Meyer's phenomenon (mydriasis in psychoneurotic patients elicited by pressure on the abdomen over McBurney's point) nor Redlich's phenomenon (mydriasis elicited by muscular activity, such as squeezing an object in the hand) was present. All these patients have been followed for over two years, and there has been no recurrence; nor has any serious disease of the central nervous system developed; admittedly, however, this interval is too short to allow serious conclusions.

COMMENT

In essence, in these cases mydriasis of the right eye occurred in myopic women, not using their glasses, who had normal vision and accommodation but showed dissociation, with slight reaction of the affected pupil on convergence only, but not to light or in accommodation. This is an intriguing picture, and the pupillary reactions to drugs add to its interest.

The average diameter of these pupils was about 8 mm., and when the patients were first seen the only effective drug was physostigmine salicylate, 1 per cent (in 2 of the 3 cases), after the use of which the pupil became 3 mm. within one-half hour. The pupillary reflexes were not changed in these eyes, however, and the pupils slowly dilated to their original state within the next eight hours. Forty-eight hours later the pupils appeared normal; they all reacted to cocaine and the response was not reversed with methacholine, but, again, physostigmine brought them down to 3 mm. Twenty-four hours later the pupils were still normal; again, epinephrine hydrochloride (1:1,000) dilated the pupils; again, methacholine had no effect, but, again, physostigmine reduced the pupils to normal size. No treatment was given for the condition, and apparently recovery has been complete in all cases.

The cause of the lesion and the site of the lesion are interesting speculations. From a review of the possible pathways involved, the most likely site of the lesion would seem to be near or in the ciliary ganglion, but of this one cannot be certain. A lesion apparently lay in the efferent constrictor fibers, but certainly there may have been a central one, producing paresis of the constrictor mechanism or acting as an irritant to the sympathetic center, supplementing the peripheral disturbance.

It is known that approximately twenty-four hours after the removal of the ciliary ganglion in the cat the dilated pupil no longer responds to physostigmine, but will react to pilocarpine. In the human subject, immediately after retrobulbar anesthesia, this condition likewise prevails. Why the time lag exists in the response of the cat is not definitely known. Since the eyes in this study responded to physostigmine, pilocarpine was not used, but from the discrepancies noted, such pupillary responses cannot at present be assumed to have definite localizing value. Perhaps if physostigmine had not given any response, one might have been led to incriminate the ciliary ganglion, but in Adie's syndrome, in which the ganglion and/or the peripheral postganglionic fibers are believed by some to be the site involved, physostigmine is effective in a modified way. In this condition, it is believed that enough intact nerve elements exist or have recovered that some acetylcholine is still liberated, which, when allowed full activity by removal of the cholinesterase by physostigmine, is effectively miotic. Although such observations are interesting, they only add to the confusion of pupillary studies and weaken their localizing value.

The presence of a slight reaction in convergence and none to light would bear out the contention that fibers for convergence and accommodation may travel to the accessory episcleral ganglion of Axenfeld or directly to ganglionic elements in the iris itself as distinct from the light fibers; but loss of the accommodation reflex leads one to the conclusion that the fibers for convergence and accommodation are separate not only from those for the light reflex but also from each other, and that the fibers for convergence are the more potent and the last affected, or the least affected.

A temporary aberrant type of Adie's syndrome was simulated, but methacholine was ineffective. If the lesion in Adie's syndrome is in the ciliary ganglion or peripheral to it, as some believe, this finding would help to place the site of the disturbance in the present cases proximal to the ganglion unless the first assumption is in complete error.

The disease picture resembles somewhat a temporary persistence of the paradoxic pupillary reaction that sometimes follows the removal or destruction of the superior cervical ganglion but which may occur when

the sympathetic nerve supply is intact. Here there is a reversion to the more primitive form of chemical activation of muscle which follows an increased sensitization to epinephrine.

The fact that the reaction to Loewi's test was positive (and still is) in all cases with positive reactions to cocaine as well complicates the problem. None of the women was pregnant, and none was in poor health or was suspected of having glaucoma. Perhaps one might deduce

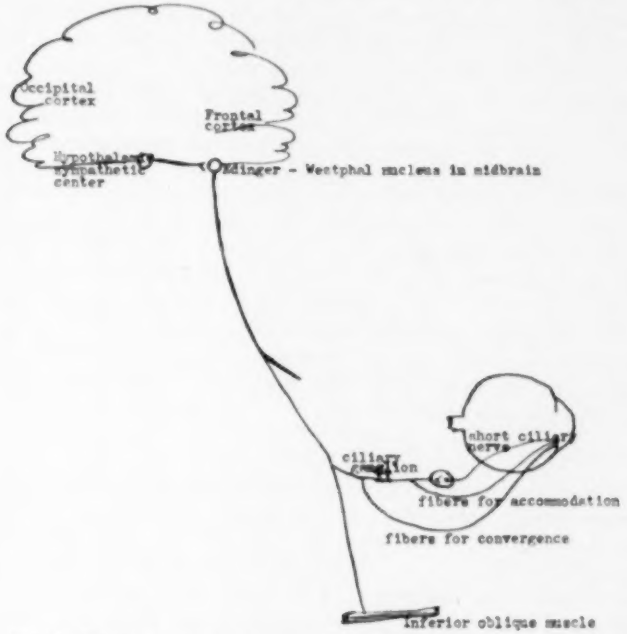

Fig. 5.—The parasympathetic pupillary system (further modified from figure 1). Note that here, however, the fibers for accommodation and convergence are separate, those for accommodation leaving just before the ciliary ganglion, so that a lesion at *XX* would spare the fibers for convergence.

therefrom that both the first (central) and the third (peripheral) sympathetic neurons were affected and that several factors were at work; namely, cerebral events, acting mainly by inhibition of the constrictor center, and peripheral events, whereby the efferent pupillary pathway is damaged at or near the ciliary ganglion or at the branch of the third nerve (*X*, fig. 1) just where it leaves the main nerve to pass to the ciliary ganglion and the accessory or the iritic ganglions, and here the

fibers for convergence resist more strongly the noxious element or elements. If the course of the fibers were as drawn in figure 5, the lesion site at *XX* would produce the same clinical picture.

Of course, the exact etiologic factor is another problem. The suddenness of appearance of the condition would lead one to believe that the origin was vascular. One supposition was that since all the patients were myopic and were not wearing lenses, there was a constant conflict in the near reflex whereby stimuli were arising constantly for the convergence reflex without the usual accompanying stimuli for the accommodation reflex and that this asynchronism in some way set up antidromal impulses, which caused a vascular reaction in or near the ciliary ganglion, the right eye being involved because all the patients were right eyed. This assumption is entirely speculative. Of course, the same confusion of impulses could have involved the central area and the relations of the Edinger-Westphal nucleus and Perlia's nucleus, as well as the sympathetic nucleus in the hypothalamus, but this possibility is still more remote. At any rate, it may be noted that 2 emmetropic volunteers wore constantly +3 lenses over each eye for three months, with no results resembling the condition in the 3 cases. It seems far fetched to assume that by prolonged dissociation of the accommodation-convergence reflex chemical substances might be elaborated to damage the effector pupillary pathways, with a pupil irresponsive to light but with a dissociated near reflex. The laterality in all these cases adds to the difficulty of any explanation.

SUMMARY

Three cases are presented of a functional unilateral mydriasis occurring in young, healthy, white, married, but nonpregnant, myopic women, not wearing glasses, whose vision was unaffected but whose pupils were immobile to light and in accommodation and reacted but slightly in convergence. The condition in these cases resembled somewhat an aberrant type of Adie's syndrome, and the usual studies revealed no clue to the cause. All the patients recovered in forty-eight hours. Pupillary studies gave interesting, but not helpful, results. A possible site of the lesion in the inferior, efferent (constrictor) branch of the third cranial nerve just after this branch leaves that to the inferior oblique muscle was suggested. Such a lesion would involve the light reflex and the near reflex (accommodation and convergence) and might conceivably leave the convergence element of the near reflex less affected. If the fibers for accommodation and convergence are separate and those for accommodation leave after those for convergence, near the ciliary ganglion, then a single lesion at the point of departure of these fibers could produce the picture observed in these cases (*XX*, fig. 5). Central lesions might also

be present in such cases and supplement the peripheral derangement. The relative rapidity of onset and recrudescence suggests a vascular cause, possibly a vasomotor phenomenon of chemical origin, conceivably related to an allergic disturbance. A not very plausible explanation is merely mentioned. The reason for the unilaterality is not clear. The syndrome was so named for want of a better appellation, even though none of the patients appeared to be psychoneurotic. Such cases probably appear oftener than the literature indicates and are of more academic than practical interest, since in none of the present cases has any permanent sequelae, ocular or otherwise, occurred during at least two years' observation. The enforced review of the anomalies of the pupillary pathways is a profitable by-product of the observations of such cases.

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STUDIES IN EXPERIMENTAL OCULAR TUBERCULOSIS

XIII. Effect of Streptomycin and Promizole® in Experimental Ocular Tuberculosis in the Normal Rabbit

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RONALD M. WOOD, Ph.D.

AND

HOWARD A. NAQUIN, M.D.

BALTIMORE

IN A PREVIOUS report,[1] it was shown that a combination of streptomycin and promizole® (4, 2'-diaminophenyl-5'-thiazolylsulfone) had a marked therapeutic effect on experimental ocular tuberculosis in immune-allergic rabbits. It is well known that experimental ocular tuberculosis runs a much severer and more fulminating course in the normal rabbit than it does in the previously infected, or immune-allergic rabbit. The following experimental studies were therefore undertaken to determine (*1*) the effect of streptomycin and promizole® on experimental ocular tuberculosis in the normal rabbit—a much severer test of the therapeutic efficacy of these agents—and (*2*) whether these agents operated independent of the immunity factor produced by a former systemic infection.

PLAN OF EXPERIMENT

Thirty normal rabbits, of both sexes, and of the same stock used in the previous experiments of this series, were inoculated in the anterior chamber of the right eye with 0.1 cc. of a six week culture of a virulent human strain of Mycobacterium tuberculosis, diluted so as to contain approximately 5 organisms per oil immersion field. The inoculations were made on Feb. 1, 1949. There was no reaction to the inoculation other than that of minor trauma, and within a week all eyes were entirely clear and asymptomatic. They remained quiet for two to three weeks, when low grade inflammation developed, with small corneal infiltrates, slight inflammation of the iris and small tubercles of the cornea and iris. Four weeks after inoculation there had developed tuberculous inflammation in the inoculated eyes of all but 1 of the rabbits, and this rabbit was discarded. The degree of tuberculous activity in each rabbit was then evaluated on a numerical scale (0 to 4), as was done in the earlier experiments in this series. The animals were divided

From the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital and University.

This work was supported in part by a grant from the John and Mary R. Markle Foundation.

1. Woods, A. C., and Wood, R. M.: Studies in Experimental Ocular Tuberculosis: XIII. Effect of Streptomycin and Promizole® in Experimental Ocular Tuberculosis in the Immune-Allergic Rabbit, Arch. Ophth. **40**:413 (Oct.) 1948.

into two groups having activity of approximately equal severity. The first group, containing 15 rabbits with an average activity of 0.8, was treated with streptomycin and promizole,* whereas the second group, containing 14 rabbits, with an average activity of 0.7, was left untreated, as a control group. Streptomycin and promizole* were given in the same dosage as in the former experiment. Fifty milligrams of streptomycin per kilogram of body weight was given subcutaneously once a day. This dosage produced blood levels of streptomycin varying between 1.7 and 5.0 mg. per hundred cubic centimeters. Promizole* was added to the food to make a 1 per cent concentration. This produced blood levels of promizole* of approximately 2.0 mg. per hundred cubic centimeters.

Treatment was started on March 1, 1949 and continued until May 27, a period of eighty-eight days. Both groups were then observed for an additional one hundred and four days. One animal in the treated group, rabbit 19, showed clinical recurrence of inflammation after cessation of treatment, and this animal was killed for histologic study eighteen days after treatment was discontinued. On September 2, one hundred and four days after cessation of treatment and two hundred and twenty days after inoculation, all remaining rabbits in the two groups were killed. The inoculated eyes of 8 of the treated rabbits were prepared for histologic study, and the inoculated eyes of 6 of the treated rabbits were prepared for culture and animal transmission. Likewise, the inoculated eyes of 8 of the control rabbits were prepared for histologic study, and the inoculated eyes of 5 of the control rabbits were prepared for culture and animal transmission.

CULTURE AND TRANSMISSION STUDIES

With aseptic precautions, the uveal tracts were dissected out, and each was macerated separately with sterile sand in 1.5 cc. of isotonic sodium chloride solution. Each of the resulting uveal suspensions was cultured on three tubes of Petragnani's medium and three tubes of Dubos' serum albumin medium.[1a] Two-tenths cubic centimeter of each suspension was also injected into the anterior chamber of a normal rabbit. The remainder of each uveal suspension was then added to separate tubes of the Dubos serum albumin medium. The inoculated eyes were observed for signs of tuberculous inflammation.

Streptomycin Resistance Studies.—Streptomycin sensitivity tests were performed on tubercle bacilli isolated from treated and from untreated rabbits to determine whether resistance to streptomycin had developed in the organisms isolated from the treated animals. The cultures for testing were taken from the Petragnani medium. Serial dilutions of streptomycin in the Dubos medium, which did not contain tween 80,* were used in the tests.

RESULTS

Clinical Course.—Figure 1 shows the clinical courses for the two groups in graphic form. The untreated, control rabbits showed a rapid progression of the tuberculous process in the eyes, reaching an average activity of 2.4 on the fiftieth day after inoculation. Thereafter, as necrosis became more evident and the eyes began to rupture, higher

1a. Petragnani's medium is widely used as a routine medium for the isolation of Myco. tuberculosis from clinical material. Dubos' medium was also used in this study because it will frequently give earlier isolations, especially when there are no interfering contaminants.

numerical values were given, so that at the cessation of treatment the activity for the controls averaged 3.2.

The course for the treated group was dramatically different. One week after the beginning of treatment little difference was apparent in the two groups. After two weeks there was a noticeable difference, the activity for the controls averaging 1.8, whereas the activity for the treated group averaged 1.0. At the end of seven weeks' treatment the difference was striking; the controls averaged 2.5, whereas in the treated group 6 of the 15 rabbits had entirely inactive disease and the average activity for the entire group was 0.2. At the end of the ninth week of treatment the average activity for the control group was 2.8, and that for the treated group, 0.05, 13 of the treated group having white eyes entirely free from activity. At the end of the tenth week of treatment the ocular disease in all the treated rabbits was entirely inactive. When streptomycin and promizole* were discontinued, the eyes of all the treated rabbits were white and free of any evidence of inflammation,

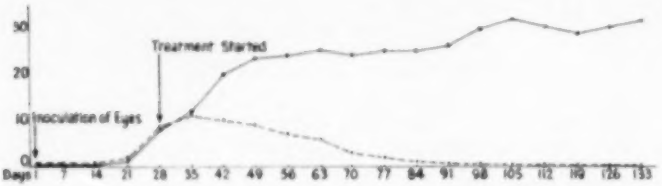

Fig. 1.—Tuberculous activity in the eyes of previously normal rabbits treated with streptomycin and promizole* (line of dashes) and in the eyes of similar untreated, control rabbits (solid line).

whereas the eyes of the control group showed advanced tuberculous disease, with an average activity of 3.2.

In figure 2, *A* and *B* are photographs of a typical untreated, control eye taken at the time treatment was commenced and at the time treatment was terminated; they illustrate the advance of the disease in untreated rabbits, with evidence of necrosis and caseation. *C* and *D* are photographs of a typical treated rabbit, showing the regression of the disease process.

Recurrences.—During the observation period of one hundred and four days following termination of treatment, 3 of the 15 treated rabbits had clinical recurrences. Rabbit 19 showed definite recurrence of inflammation four days after cessation of treatment. This progressed slowly to an estimated activity of 1.5, when the animal was killed for histologic study. The eye showed a characteristic picture of tuberculous infiltration and fresh active tubercles. Two other rabbits (13 and 14) showed minimal recurrences on the fifty-ninth and seventy-first days, respectively, after cessation of treatment. There were no clinical recur-

rences in the remaining 12 treated rabbits, although, as hereafter noted, 2 of the rabbits with clinically inactive disease showed histologic evidence of active disease and 4 of the rabbits killed for cultures and transmission experiments had infectious uveas.

Culture and Transmission Studies.—Table 1 shows the results of these studies. Four of 6 uveas from the treated rabbits showed growths of Myco. tuberculosis on all the culture mediums, whereas 2 of the

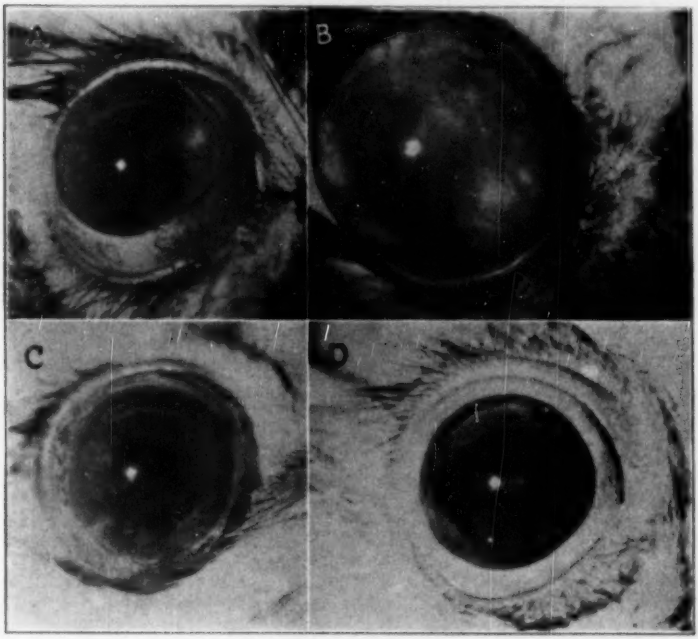

Fig. 2.—*A* and *B*, untreated, control, eyes at the beginning and at the termination of the treatment period, respectively, showing advance of the disease; *C* and *D*, eyes of treated rabbits, at the beginning and the termination of treatment, showing regression of the disease.

TABLE 1.—*Cultures and Transmissions*

	Treated Rabbits						Untreated Rabbits				
	1	2	3	4	5	6	12	18	21	27	34
Petragnani's medium	+	+	—	+	+	—	+	+	+	+	+
Dubos' (albumin) medium	+	+	—	+	+	—	+	+	+	+	+
Dubos' medium and macerated uvea	+	+	—	+	+	—	+	+	+	+	+
Transmission	+	+	—	+	+	—	+	+	+	+	+
Incubation period, days	20	20	0	20	20	0	13	13	13	13	13

uveas gave sterile cultures on all mediums. All 5 of the uveas of the control group yielded growths on all the mediums. The transmission studies confirmed the results of culture. All the uveas, both of the treated and of the untreated rabbits, which gave positive cultures also

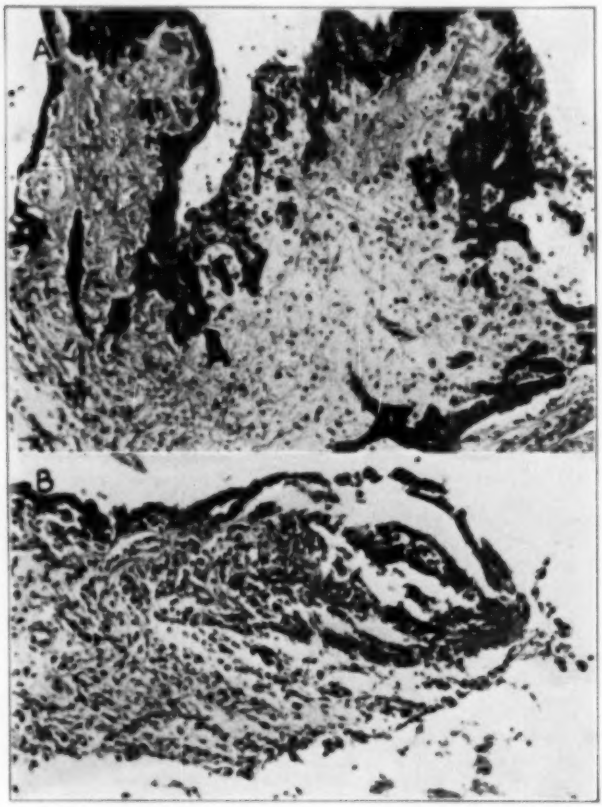

Fig. 3.—Inoculated eyes of rabbits one hundred and four days after cessation of treatment with streptomycin and promizole.* *A* (rabbit 10), mild, diffuse round cell infiltration, not characteristic of tuberculosis; *B* (rabbit 13), tuberculous infiltration of the cornea and iris.

produced typical lesions of active ocular tuberculosis in the inoculated eyes of normal rabbits. The interval, expressed in days, between inoculation and the visible appearance of tuberculous activity is shown for each rabbit in table 1.

Resistance of Myco. Tuberculosis to Streptomycin. — Cultures obtained from 3 treated animals (rabbits 1, 2 and 4) and from 3 control animals (rabbits 12, 21 and 24) were tested for sensitivity to strepto-

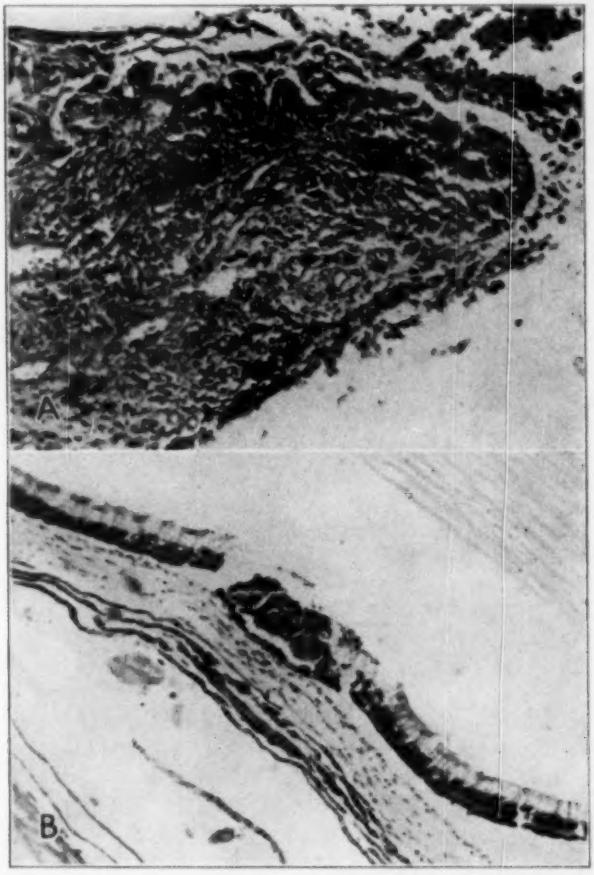

Fig. 4.—Inoculated eyes of rabbits one hundred and four days after cessation of treatment. *A* (rabbit 14), tuberculous infiltration of the iris; *B* (rabbit 15), small tubercle in the anterior portion of the retina but no clinical evidence of tuberculosis.

mycin. The cultures from the untreated animals were sensitive to 0.26 microgram of streptomycin per cubic centimeter of total volume. The

organisms isolated from the treated animals showed a sensitivity of 0.53 microgram per cubic centimeter.

Histologic Picture in Treated Rabbits.—The inoculated eyes of 8 treated rabbits were sectioned for histologic study one hundred and four

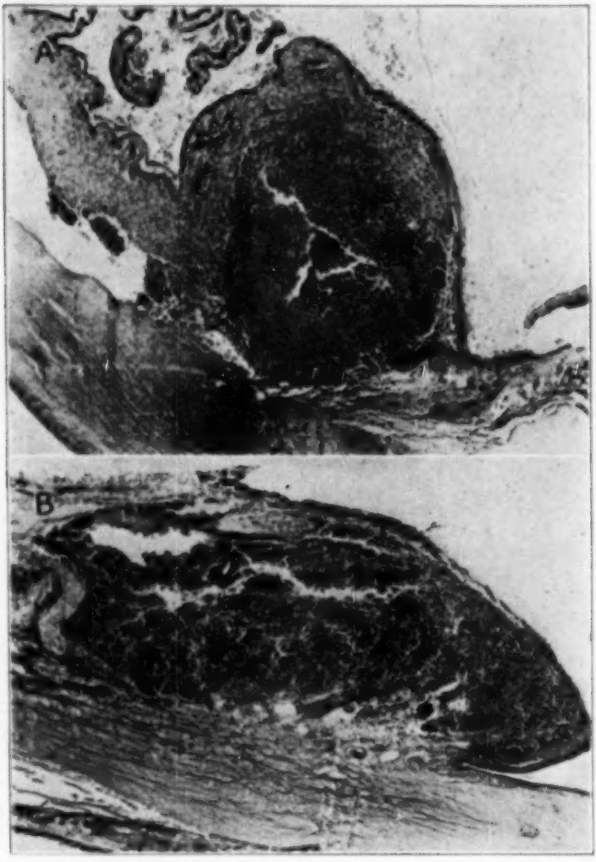

Fig. 5.—Inoculated eyes of rabbits one hundred and four days after cessation of treatment. *A* (rabbit 15), large caseous tubercle at the root of the iris; *B* (rabbit 17), episcleral tuberculous lesion. Neither eye showed clinical evidence of tuberculosis.

days after cessation of treatment. At that time the eyes of 6 of these rabbits showed no evidences of inflammation or disease activity, whereas

the eyes of 2 showed evidences of a low grade, smoldering activity of forty-five and thirty-three days' duration, respectively.

On histologic study, the eyes of 3 rabbits with clinically inactive tuberculosis (8, 9 and 11) showed no trace of any activity, the sections appearing entirely normal except for minimal scarring. The eye of 1 rabbit (10) showed a mild, diffuse round cell infiltration of the ciliary body and a small collection of lymphocytes around an old scar, with a few wandering cells in the posterior chamber, but nothing in the picture characteristic of tuberculosis (fig. 3 *A*). The eyes of the remaining 4 rabbits showed definite tuberculous lesions: tuberculous infiltrations in the cornea and iris (rabbit 13, fig. 3 *B*); tuberculous infiltration in the iris (rabbit 14, fig. 4 *A*) and at the periphery of the cornea; a large caseous tubercle at the root of the iris (rabbit 15, fig. 5 *A*), and a small tubercle in the anterior part of the retina (fig. 4 *B*), and an episcleral tuberculous lesion with the eye entirely normal (rabbit 17, fig. 5 *B*).

It was interesting that, whereas rabbits 13 and 14 showed clinical evidences of low grade inflammation, in accordance with the histologic changes, rabbit 15, with a single large caseous, fairly well encapsulated tubercle in the ciliary body, and rabbit 17, with a histologically clear-cut episcleral lesion, showed no clinical evidence of any inflammatory process.

COMMENT

The results of this experiment may be summarized as follows: The therapeutic effects of the combined use of streptomycin and promizole® in the control of the clinical inflammation were manifest after two weeks of treatment, and after ten weeks of treatment the disease in the eyes of all the treated animals was clinically inactive. After cessation of treatment, one eye relapsed in four days, and 2 others, at fifty-nine and seventy-one days, respectively. These eyes all showed histologic evidences of active tuberculosis. The eyes of the remaining treated rabbits remained clinically free of any tuberculous activity, but on culture and transmission experiments viable bacilli were demonstrated in 4 of 6 studied. Of the 9 rabbits killed for histologic examination of the eyes, evidences of active tuberculosis were present in 5. Thus, while there was complete prompt symptomatic control of the ocular tuberculosis by treatment with streptomycin and promizole® in all 15 rabbits, there were clinical recurrences in 3 rabbits and either histologic or bacteriologic evidences of viable organisms in 6 of the others. Expressed in percentages, this indicates a presumptive complete cure of 40 per cent of the normal rabbits.

The results in these normal rabbits are not strictly comparable to those obtained in immune-allergic animals (previously reported). In the normal rabbit there was a longer period of post-treatment observa-

tion, and the histologic study, cultures and transmission experiments were made at the end of this period, instead of immediately after cessation of treatment, as was done in the immune-allergic group. However, for what such a comparison is worth, the results in the immune-allergic group may be summarized as follows: A perceptible improvement was noted at the end of two weeks' treatment, and after eight weeks the disease appeared clinically inactive. One of 9 treated rabbits (11 per cent) showed a recurrence thirty-four days after cessation of treatment, the entire period of post-treatment observation being only fifty-six days. Sections of 6 eyes taken immediately after cessation of treatment and of 8 eyes taken fifty-six days later showed no histologic evidences of active tuberculosis. On culture, the uvea of only 1 of the treated animals yielded the bacilli on culture, but in transmission experiments done

TABLE 2.—*Comparative Action of Streptomycin and Promizole® on Ocular Tuberculosis in Normal and in Immune-Allergic Rabbits*

Type of Animal	Immediate Reaction	Clinical Recurrences	Histologic Evidences of Active Tuberculosis	Cultures	Transmission Experiments	Over-All Presumptive Cure
Immune-allergic	Improvement in 2 weeks; clinical inactivity in 8 weeks	11% (1 of 9 animals—56 days)	0% (1 of 15 eyes; 9 rabbits killed immediately, and 6 56 days, after cessation of treatment)	17% (1 of 6) cultures immediately after cessation of treatment	50% (3 of 6 tested immediately after cessation of treatment)	80% (17 of 21)
Normal	Improvement in 2 weeks; clinical inactivity in 9 weeks	30% (3 of 15 animals—104 days)	89% (8 of 9 rabbits killed 104 days after cessation of treatment)	67% (4 of 6 cultures 104 days after cessation of treatment)	66% (4 of 6 tested 104 days after cessation of treatment)	40% (6 of 15)

immediately after cessation of treatment, 3 of 6 rabbits showed infectious uveas, indicating that there were living bacilli in the eye. Thus, while the recurrences and bacteriologic and histologic evidences of active tuberculosis were less in the immune-allergic group (11 per cent), the incidence of the living bacilli, as evidenced by transmission experiments, were statistically the same in these two groups. These comparable figures for the two groups are shown in table 2.

The increased incidence of recurrences, of histologic evidences of active tuberculosis and of growths of the bacillus on culture in the previously normal group may be due to any of the following factors: 1. The longer period of post-treatment observation, one hundred and four days against fifty-six days, allowed time for latent clinical recurrences to become manifest. 2. In the previously normal group, the eyes were sectioned one hundred and four days after cessation of treatment, whereas in the immune-allergic group such sections were made immediately after treatment was stopped. Any bacilli in latent tuberculous lesions, primarily controlled by the bacteriostatic action of the antibiotic and the sulfone drug, had ample time to increase after treatment was

discontinued, and so again to produce active lesions. 3. Similarly, the longer period before culture of the uveal tracts—one hundred and four days instead of immediately after cessation of treatment—allowed any viable bacilli to multiply sufficiently to give growth on culture, it being well recognized that in any culture only a minimal implant of organisms is necessary to produce a growth. 4. The factor of systemic immunity was absent in the normal group.

The first three explanations offered are all similar, namely, that the prolonged period of observation before histologic study, cultures and transmission experiments were made, accounts for the increase in recurrence and the heightened incidence of histologic and bacteriologic evidences of living bacilli in the eyes. This appears a quite sufficient explanation without the attempt to explain the finding on the grounds of the absence of systemic immunity. This statement is borne out by the observation that the transmission experiments, a much more delicate test for the presence of living bacilli, gave essentially the same results in the two groups. This seems to indicate that the action of streptomycin and promizole® on ocular tuberculosis is bacteriostatic and bacteriocidal, and that these agents operate independent of the immunity factor.

Of especial interest in the experiment here reported is the observation that 2 rabbits (15 and 17) had definite histologic evidences of tuberculosis in eyes without signs of external inflammation or clinical evidences of active disease. This is in line, of course, with the well known clinical observation that tuberculous eyes go through periods of clinical remission, whereas later exacerbations indicate there must have been a continuing active process in the eye. In rabbit 15 the location of the caseous tubercle back of an essentially normal iris explains the absence of clinical findings. It is strange, however, that the episceral lesion in rabbit 17 gave no external evidence of inflammation.

It is of interest that in this experiment the amount of resistance to streptomycin developed by Myco. tuberculosis was not as great as is usually found when streptomycin is given alone. In vitro [2] experiments have shown that the development of resistance to streptomycin and diphenyldiaminosulfones is retarded when the mycobacterium is exposed to both agents simultaneously. It is therefore quite probable that the decreased development of resistance to streptomycin may be related to the combined use of the promizole.®

The over-all picture of the experiment is encouraging. In a severe test of the efficacy of these therapeutic agents, there was an immediate clinical arrest of the advancing pathologic process in 100 per cent of the

2. Middlebrook, G., and Yegian, D.: Certain Effects of Streptomycin on Mycobacterium in Vitro, Am. Rev. Tuberc. **54**:553, 1946.

eyes. During a period of observation of one hundred and four days after cessation of treatment, there was further evidence of complete clinical cure and absolute sterilization of the eyes in 40 per cent of the treated animals, whereas the remaining 60 per cent showed evidence of viable bacilli remaining in the eye.

These experimental results are roughly in accord with the results in human subjects. In the preliminary clinical report, it was stated that in 14 consecutive patients with frank ocular tuberculosis there was a complete halt to the advancing pathologic process with regression of all reversible changes after treatment with streptomycin and promizole.* Since this report there have been definite recurrences in 2 of these patients.

Thus, the experimental and clinical evidence to date indicates that treatment of ocular tuberculosis with streptomycin and promizole* effects a control of the clinical evidences of active tuberculosis, and in some cases a complete cure. This therapeutic effect is due primarily to a bacteriostatic action on the invading bacilli, although in many cases there appears to be an actual bacteriocidal action, with destruction of the organisms and sterilization of the tissues. It is quite probable that more prolonged treatment, or several courses of treatment, may increase greatly the favorable action of these agents.

SUMMARY

The effect of streptomycin and promizole* on experimental ocular tuberculosis in the normal rabbit is reported. Under the experimental conditions, there was complete control of visible inflammatory activity in all 15 animals. During the post-treatment observation period of one hundred and four days, there were visible inflammatory recurrences in only 3 rabbits. At the time the animals were killed 9 rabbits (60 per cent) showed either bacteriologic or histologic evidence of active ocular tuberculosis, whereas 6 (40 per cent) showed evidence, either bacteriologic or histologic, of complete cure.

Johns Hopkins Hospital.

STUDIES IN EXPERIMENTAL OCULAR TUBERCULOSIS

XIV. Failure of Aureomycin to Affect the Course of Ocular Tuberculosis

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AND
HOWARD A. NAQUIN, M.D.
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AUREOMYCIN has been shown to be successful in the treatment of a wide variety of infectious diseases.[1] It has also been shown that resistance to aureomycin by many organisms is developed much more slowly and to a less degree than is resistance to streptomycin.[2] Braley and Sanders [3] reported 2 cases of tuberculous uveitis in which decided improvement followed treatment with aureomycin. Schoenbach [4] treated 6 patients with various forms of tuberculosis. Two of these 6 showed improvement, 1 with a renal infection, the other with scrofulous draining sinuses of the neck.

Steenken and Wolinsky [5] found the in vitro sensitivity of the H37 RV strain of Mycobacterium tuberculosis to vary from 5 to 40 micrograms per cubic centimeter, depending on the medium used for the assay. These authors treated the disease in guinea pigs with aureomycin and concluded that the course of the clinical disease was not affected.

From the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital and University.

This investigation was supported in part by a grant from the John and Mary R. Markle Foundation.

1. Long, P. H.; Schoenbach, E. B.; Bliss, E. A.; Bryer, M. S., and Chandler, C. A.: The Experimental and Clinical Use of Polymyxin, Chloromycetin, and Aureomycin, California Med. **70**:1, 1949.

2. Price, C. W.; Randall, W. A., and Welch, H.: Bacteriological Studies of Aureomycin, Ann. New York Acad. Sc. **51**:211, 1948.

3. Braley, A. E., and Sanders, M.: Aureomycin in Ocular Infections: A Study of Its Spectrum, Ann. New York Acad. Sc. **51**:280, 1948.

4. Schoenbach, E. B.: The Newer Antibiotics: Polymyxin, Chloromycetin, and Aureomycin (Janeway Memorial Lecture), J. Mt. Sinai Hosp. **16**:71, 1949.

5. Steenken, W., Jr., and Wolinsky, E.: Tuberculostatic Activity of Aureomycin in Vitro and in Vivo, Am. Rev. Tuberc. **59**:221, 1949.

In view of the somewhat conflicting evidence, therefore, it seemed pertinent to evaluate the effect of aureomycin on the progress of experimental ocular tuberculosis in the rabbit.

PLAN OF EXPERIMENT

On June 6, 1949, 24 adult rabbits were given an injection into the anterior chamber of 0.1 cc. of a suspension of virulent Myco. tuberculosis, var. hominis. This suspension had been adjusted so that when a 2 mm. platinum loopful was spread over an area of 1 sq. cm. there was an average count of 50 organisms per oil immersion field. The animals were observed at weekly intervals, and the degree of tuberculous activity in each eye was then evaluated on a numerical scale, just as was done in the former experiments in this series, already reported. At the end of twelve days, when early ocular changes were well established (June 18), the animals were divided into two groups, so that each group had a tuberculous activity of the same average severity. In actual figures, group 1, the control group, consisted of 13 rabbits, with an average reaction of 1.44; group 2, the group to be treated, consisted of 11 animals, with an average reaction of 1.45.

Treatment was begun on June 18. Each animal in group 2 received 20 mg. of aureomycin hydrochloride in aminoacetic acid (glycine) buffer[6] per kilogram of body weight. The injections were given subcutaneously once each day. The eyes of both groups were observed at weekly intervals, and the reactions were tabulated and averaged. Aureomycin levels in the blood were determined by the method of Dornbush and Pelcak.[7] Treatment was discontinued on July 23, and one week later the eyes of both groups were removed, and the uveal tracts were macerated with sterile sand and cultured on Dubos' medium.[8]

RESULTS

The results are shown in graphic form in the chart and in tabular form in table 1. During the five week period of observation, there was a steady progress of the tuberculous disease in the eyes of both of the untreated controls and of the rabbits treated with aureomycin. This

6. This preparation was supplied by Lederle Laboratories, Inc., Pearl River, N. Y.

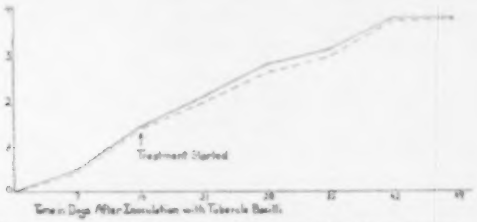
7. Dornbush, A. C., and Pelcak, E. J.: The Determination of Aureomycin in Serum and Other Body Fluids, Ann. New York Acad. Sc. **51**:218, 1948.

8. Dubos' medium has the following formula: (J. Exper. Med. **83**:409 [May] 1946):

Asparagine or hydrolysate of casein	1.0 Gm.
Sodium phosphate	0.3 Gm.
Potassium phosphate	1.0 Gm.
Sodium citrate	1.5 Gm.
Dissolve, then add	
Magnesium sulfate	0.6 Gm.
Distilled water to 1,000 cc.	

progress was of equal severity in the two groups. At the conclusion of treatment, on July 23, the majority of the eyes of both groups had ruptured and showed advanced necrosis and caseation.

At the conclusion of the experiment, the eyes of both control and treated rabbits were removed. All tubes inoculated with the macerated uveal tracts of the excised eyes showed a heavy growth of Myco. tuberculosis, there being no perceptible difference in the incubation period or the growth in the control and in the treated rabbits.



Tuberculous activity in the eyes of rabbits treated with aureomycin. The curve for rabbits treated with aureomycin is the line of dashes; the curve for the untreated controls, the solid line.

TABLE 1.—*Weekly Average Readings for Tuberculous Activity in Eyes of Treated and of Control Group*

Date	Treated Group	Control Group
7/12/49	0.43	0.46
7/18/49	1.45	1.44
7/25/49	1.97	2.06
8/ 1/49	2.56	2.78
8/ 8/49	2.97	3.13
8/15/49	3.75	3.80
8/22/49	3.79	3.80

COMMENT

These results clearly indicate that under the conditions of this experiment aureomycin had no deterrent effect whatever on the development or course of ocular tuberculosis in the normal rabbit. There is little reason to believe that had the doses been larger the results could have been different. As seen in table 2, four hours after injection the blood levels of aureomycin averaged 2.8 micrograms, and twenty hours after injection they averaged 1.4 micrograms, per cubic centimeter of serum. Evidently, a reasonable blood level of aureomycin was sustained. Further, it is doubtful whether the animals would have tolerated a larger dose. The dose administered caused a certain degree

of local necrosis at the site of injection, although this was not of sufficient severity to warrant a discontinuation of the therapy or an alteration of the dose.

The secretion of the drug in the humors of the eye was not determined in these experiments, the point at issue being whether or not the antibiotic administered in comparatively large doses had any effect on ocular tuberculosis. The drug is known to be excreted in the urine, where the concentration is high. This may explain the favorable result in a case of urogenital tuberculosis reported by Schoenbach. However, there is nothing in the results here reported to indicate aureomycin has the slightest deterrent action on tuberculosis.

TABLE 2.—*Aureomycin Levels in the Serum Four and Twenty Hours After Injection*

Rabbit No.	Aureomycin Levels, Micrograms/Cc. Serum	
	Four Hours	Twenty Hours
1	2.0	1.0
2	2.0	2.0
3	4.0	2.0
4	2.0	1.0
5	2.0	1.0
6	4.0	1.0
7	4.0	1.0
8	2.0	2.0
9	4.0	2.0
10	2.0	1.0
11	2.0	1.0
12 (control)	0	0

CONCLUSION

Aureomycin administered in the dose of 20 mg. per kilogram of body weight once daily over a thirty-five day period gave sustained blood levels between 2.8 and 1.4 micrograms per cubic centimeter of serum in the rabbit. This dose and blood concentration of aureomycin had not the slightest deterrant action on ocular tuberculosis experimentally produced in the normal rabbit.

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CHOLINE ACETYLASE ACTIVITY IN OCULAR TISSUES

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IN 1943 Nachmansohn and Machado [1] discovered a new enzyme, choline acetylase, which in cell-free solution, under strict anaerobic conditions and in the presence of adenosine triphosphate, synthesizes acetylcholine in vitro. The presence of the enzyme was demonstrated in [2] nerve-containing and muscle-containing tissues of a wide variety of animals, viz., in those tissues that also contain an appreciable amount of cholinesterase. Since the acetylase forms and the esterase splits acetylcholine, such a finding should not be surprising. To demonstrate the presence of choline acetylase in ocular tissues, the following experiment was undertaken.

METHOD

Preparation of the Enzyme.—The acetone-dried powder method as described by Nachmansohn and John [2c] was employed, since it yields higher values than the fresh tissue homogenates. The animals were killed, the eyes enucleated and the tissues dissected and placed immediately into solid carbon dioxide, such a step being necessary because choline acetylase, being a very labile enzyme, deteriorates within a few minutes after the death of the animal. To obtain sufficient material, several eyes were pooled for each experiment, and the frozen tissues were homogenized in a Potter-Elvehjem tube for two minutes with a few milliliters of phosphate

This study was supported by the Knapp Memorial Foundation.

From the Department of Ophthalmology, Columbia University College of Physicians and Surgeons.

1. Nachmansohn, D., and Machado, A. L.: The Formation of Acetylcholine. A New Enzyme: "Choline Acetylase," J. Neurophysiol. **6**:397, 1943.

2. (*a*) Nachmansohn, D.; John, H. M., and Waelsch, H.: Effect of Glutamic Acid on the Formation of Acetylcholine, J. Biol. Chem. **150**:485, 1943. (*b*) Nachmansohn, D., and John, H. M.: On the Formation of Acetylcholine in the Nerve Axon, Science **102**:250, 1945; (*c*) Studies on Choline Acetylase: I. Effect of Amino Acids on the Dialyzed Enzyme, J. Biol. Chem. **158**:157, 1945. (*d*) Nachmansohn, D.; John, H. M., and Berman, M.: Studies on Choline Acetylase: II. The Formation of Acetylcholine in the Nerve Axon, ibid. **163**:475, 1946. (*e*) Nachmansohn, D., and Berman, M.: Studies on Choline Acetylase: III. On the Preparation of the Coenzyme and Its Effect on the Enzyme, ibid. **165**:551, 1946. (*f*) Nachmansohn, D.; Berman, M., and Weiss, M. S.: Presence of Choline Acetylase in Striated and Cardiac Muscle, ibid. **167**:295, 1947. (*g*) Nachmansohn, D., and Weiss, M. S.: Studies on Choline Acetylase: IV. Effect of Citric Acid, ibid. **172**:677, 1948.

buffer. The homogenate was poured into ice cold acetone at 0 ± 2 C. for the extraction. One must be careful not to allow the temperature to rise above 2 C., because warm acetone destroys choline acetylase. After acetone extraction, the solution was filtered through a Buchner funnel and the precipitate dried and weighed. This dry powder remains stable for several weeks if placed in a desiccator and kept in the deep freezer.

Testing of the Acetone-Extracted Enzyme.—A weighed portion of the powder was dissolved in a phosphate buffer. In order that optimum enzyme activity might be obtained, according to Nachmansohn's theory,[37] the following substances had to be added to complete the acetylating system: choline, acetate, cysteine, coenzyme, adenosine triphosphate and physostigmine. Adenosine triphosphate furnishes the energy-rich phosphate bonds, while the coenzyme, found in a variety of tissues, such as liver and lung, is essential for the activity of the enzyme. In our case the addition of the cholinesterase inhibitor physostigmine is not essential, since acetone destroys most of the cholinesterase. However, if one determines the acetylating activity of a fresh tissue homogenate, a cholinesterase inhibitor, preferably physostigmine or tetraethylpyrophosphate, must be used.

Choline Acetylase Activity Expressed in Micrograms of Acetylcholine Formed per Gram of Powder per Hour

Preparation No.	No. Eyes	Choline Acetylase Activity		
		Iris	Ciliary Body	Retina
Cat				
1	4	166	562	400
2	6	140	471	562
3	4	150	375	300
Average		139	370	420
Rabbit				
1	10	90		600
2	6	120		660
Average		105		655

The reaction mixture was then incubated in a water bath for twenty minutes at 37 C. because the enzyme activity shows a straight line relationship for that period, falling off rapidly thereafter.

The amount of acetylcholine formed in the reaction mixture was determined by the frog bioassay method of Chang and Gaddum.[3] The frog rectus abdominis muscle is suspended in Ringer's solution to which physostigmine has been added and attached to a lever, the excursions of which are measured in arbitrary units. Each unknown determination was bracketed between two solutions of known acetylcholine concentrations, and adequate time was allowed between each test for the muscle to rest.

RESULTS

Three acetone powder preparations each were made from the iris, the ciliary body and the retina of the cat, and two preparations each from the same tissues of the rabbit. The iris and the ciliary body of the

3. Chang, H. C., and Gaddum, J. H.: Choline Esters in Tissue Extracts, J. Physiol. **79**:255, 1933.

rabbit were combined, since their careful anatomic separation is impossible. The accompanying table demonstrated that all the tissues examined showed choline acetylase activity, the values being expressed in micrograms of acetylcholine formed per gram of powder per hour. The retinas of both species of animals, as well as the ciliary body of the cat, had about the same activity, but the rabbit iris and ciliary body and the cat iris showed lower enzyme values. If the relative values for choline acetylase in these different tissues are compared with the cholinesterase activity rates reported by me,[4] a close parallel is found to exist. For example, in the rabbit the retina contains five times as much cholinesterase as the iris and ciliary body, while for choline acetylase rates the ratio is 6:1 for these tissues. In the cat a similar condition is found to exist. Thus, it can be said that in the ocular tissues examined the degree of cholinesterase activity corresponds closely to the activity of the choline acetylase. Nachmansohn reported the same correlation between these two enzymes for several other nerve-containing and muscle-containing tissues.

COMMENT

A certain amount of skepticism must be expressed before one can accept the reported values as valid. Choline acetylase is a relatively new enzyme, and knowledge of its general properties is by no means complete. As stated previously, choline acetylase is an extremely delicate enzyme and deteriorates rapidly on the death of the animal. It is not known how much of the total enzyme content is recovered with the acetone extraction method; during this extraction the enzyme is sensitive to slight changes in the temperature of the acetone. It is equally important that the p_H of the reaction mixture in the incubator be carefully controlled, since slight shifts in the p_H make decided differences in the results of the test. Thus, it is more than probable that with present day methods only a fraction of the total choline acetylase activity can be recovered. But, in spite of these difficulties, it was shown that measurable amounts of the enzyme were found in the muscle-containing and nerve-containing ocular tissues, i. e., the iris, ciliary body and retina. This observation completes another link in the "acetylcholine cycle" so far as certain ocular tissues are concerned; choline acetylase and cholinesterase, the enzymes that synthetize and destroy acetylcholine, were found in appreciable concentrations in the muscle-containing and nerve-containing tissues of the eye.

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4. deRoetth, A., Jr.: Cholinesterase Activity in Ocular Tissues and Fluids, to be published.

SUMMARY

Choline acetylase, the enzyme responsible for the synthesis of acetylcholine, was found in measurable amounts in the iris, ciliary body and retina of the cat and rabbit.

The relative rates of choline acetylase activity were approximately parallel to the relative rates of cholinesterase activity found in these tissues.

Dr. David Nachmansohn placed his laboratory at my disposal for part of the experimental work, and Dr. L. Wiggins assisted with the dissection of the ocular tissues.

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INFECTIOUS MONONUCLEOSIS COMPLICATED BY BILATERAL PAPILLORETINAL EDEMA

Report of a Case

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AND
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DURING the last fifteen years the literature on infectious mononucleosis has increased greatly,[1] and with this addition has come the realization that the signs and symptoms of the disease are manifold and its clinical behavior not always predictable. In 1941 Thelander and Shaw [2] reviewed the cerebral complications but did not mention papilloretinal edema. In 1948 Tidy [3] reviewed the neurologic findings, but likewise did not mention retinal edema. Ashworth and Motto [4] in 1947 reported a case of infectious mononucleosis complicated by bilateral papilloretinal edema in the absence of a clinical picture of

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1. Schmidt, J., and Nyfeldt, A.: Infectious Mononucleosis and Meningo-Encephalitis, Ugesk f. laeger **100**:336, 1938; abstracted, J. A. M. A. **110**:1884 (May 28) 1938. Tidy, H. L.: Glandular Fever and Infectious Mononucleosis, Lancet **2**:180 and 236, 1934. Zohman, B. L., and Silverman, E. G.: Infectious Mononucleosis and Encephalomyelitis, Ann. Int. Med. **16**:1233, 1942. Landes, R.; Reich, J. P., and Perlow, S.: Central Nervous System Manifestations of Infectious Mononucleosis, J. A. M. A. **116**:2482-2484 (May 31) 1941. Epstein, S. H., and Dameshek, W.: Involvement of Central Nervous System in Case of Glandular Fever, New England J. Med. **205**:1238-1241, 1931. Johansen, A. H.: Serous Meningitis and Infectious Mononucleosis, Acta. med. Scandinav. **76**:269-272, 1931. Ricker, W.; Blumberg, A.; Peters, C. H., and Widerman, A.: The Association of the Guillain-Barré Syndrome with Infectious Mononucleosis, Blood **2**:217-226, 1947. Bethell, F. H.; Sturgis, C. C.; Hettig, R. A., and Mallery, O. T., Jr.: Blood: Review of Recent Literature, Arch. Int. Med. **69**:1051-1126 (June) 1942. Philip, A. J.: Infectious Mononucleosis: Unusual Case, New York State J. Med. **41**:1664-1665, 1941. Fowler, W. M., and Tidrick, R. T.: Unusual Manifestations of Infectious Mononucleosis, Am. J. Clin. Path. **10**:548-553, 1940.

2. Thelander, H. E., and Shaw, E. B.: Infectious Mononucleosis, with Special Reference to Cerebral Complications, Am. J. Dis. Child. **61**:1131-1145 (June) 1941.

3. Tidy, H.: Infectious Mononucleosis, Blood **3**:823-829, 1948.

4. Ashworth, J., and Motto, S. A.: Infectious Mononucleosis Complicated by Bilateral Papilloretinal Edema, New England J. Med. **237**:544-545, 1947.

meningitis or encephalitis. No other reports in which papilloretinal edema was one of the major features have since appeared. The following case was of considerable interest to us because of the confusion of the history that colored the differential diagnosis. The laboratory data and the subsequent progression of clinical events substantiated the diagnosis of infectious mononucleosis complicated by bilateral papilloretinal edema.

REPORT OF CASE

History.—E. G., a man aged 23, was admitted to the Barre City Hospital, March 5, 1949, because of severe headaches and nausea. The history revealed that on Feb. 4, 1949 the patient, who worked in a quarry, was struck on the forehead by a derrick hook. He was temporarily stunned but had only a trivial abrasion. He had some headache after that, but attributed the headache to a bad cold which he had at the time. He was treated by his physician for the cold and supposedly recovered. The headaches recurred on February 25 and increased in frequency and severity until March 4, when they were impossible to control by sedation. On March 3 the patient broke out with urticaria, which cleared that day but recurred the following day, accompanied with a bout of vomiting.

His past history revealed that he had had the usual diseases of childhood and three bouts of pneumonia, at the ages of 6, 15 and 21. He had served in the Navy during World War II but had never been hospitalized for serious illness, nor had he ever been wounded. He denied having had venereal disease. The family history revealed that his mother had recently had a thoracoplasty for tuberculosis. The other members of the family are all well.

Examination.—Physical examination revealed a thin white man, 5 feet 6 inches in height (167.6 cm.) and weighing approximately 115 pounds (52.1 Kg.). He was dehydrated and appeared to be somewhat in distress. The skin was warm and extremely flushed, almost to the point of showing a diffuse erythema. The conjunctivas were excessively moist and were injected. The patient complained of "aching" of the eyes on movement. The pupils were dilated and sluggish. There was no nystagmus. Inspection of the tympanic membranes did not reveal any abnormality; they were intact and demonstrated a normal light reflex. Funduscopic examination revealed bilateral papilloretinal edema of approximately 3 D. There was no change in the vessels or evidence of exudate. The neck was freely mobile, but the patient complained of muscular pain in the posterior group of muscles of the neck. The thyroid gland and the lymph nodes were not palpably enlarged. The oropharynx was normal. The tonsils had been removed. The lungs and heart were normal. The blood pressure was 105 systolic and 55 diastolic. The aortic second sound was greater than the pulmonic second sound. The abdomen was scaphoid and somewhat muscular. There was no area of tenderness, and the liver, spleen and kidneys could not be palpated. The anus and rectum were clear; the genitourinary system and the bones and joints were normal. Examination of the muscular system revealed no weakness, atrophy or fibrillation. The reflexes were all of physiologic type. The temperature was 102 F.; the pulse rate 100 and the respiration rate 20.

In view of the history of a blow on the head and of open tuberculosis in the mother, for which thoracoplasty had been carried out, chronic subdural hemorrhage and tuberculous meningitis were considered in the differential diagnosis.

Lumbar puncture, performed on the day of admission, revealed a pressure of 10 mm. of mercury and normal dynamic state. The fluid contained 6 cells per cubic millimeter, 4 of which were lymphocytes and 2 polymorphonuclear leukocytes. The Pandy reaction for globulin was slightly positive. The total protein of the fluid measured 51 mg., the sugar 53 mg. and the chlorides 710 mg. per hundred cubic centimeters. The specimen yielded no growth on culture. The Wassermann reaction was negative. The urine was normal. Examination of the blood revealed a red cell count of 4,910,000, a hemoglobin concentration of 104 per cent (Sahli method) and a white cell count of 7,050, with 49 per cent polymorphonuclear leukocytes, 47 per cent lymphocytes, 1 per cent eosinophils and 3 per cent monocytes. No morphologic abnormalities were present. Roentgenograms of the skull did not reveal any lesion.

Course of Illness.—March 7: The patient complained of cramplike pain in the upper part of the abdomen. The skin was warm and flushed from the shoulders to the waist. The white blood cell count was 5,070, with 50 per cent polymorphonuclear leukocytes, 2 per cent eosinophils and 2 per cent monocytes.

March 8: The abdominal discomfort continued. He complained of seeing spots and pinpoints of fire before his eyes. Funduscopic examination revealed the persistent papilloretinal edema.

March 9: The patient had profuse diaphoresis.

March 10: He vomited and complained of inability to move his left arm from the shoulder to the elbow. The white blood cell count was 13,250, with 11 per cent polymorphonuclear leukocytes, 85 per cent lymphocytes and 4 per cent monocytes. The lymphocytes were large and showed the reticulation and vacuolation characteristic of infectious mononucleosis. The results of a test for heterophil antibody, performed on March 8, was reported as positive for the disease in a dilution of 1:448; the reaction to the Davidsohn test was also positive. Aspiration of bone marrow revealed hyperplastic marrow, with myelocytes predominating in the granular series. That evening the inguinal lymph nodes were found to be greatly enlarged and the spleen was palpable 5 cm. below the costal margin. The abdomen was extremely tender to palpation in the left upper quadrant. The papilloretinal edema cleared up. A lymph node which was removed revealed on section the characteristic picture of infectious mononucleosis. Imprints of the node revealed the reticulation and vacuolation of the lymphocytes.

March 11 to 16: He complained of abdominal pain and of pain in the neck, shoulders and elbow joints.

March 15: The red cell count was 5,310,000 with 104 per cent hemoglobin. The white cell count was 10,200, with 30 per cent polymorphonuclear leukocytes and 70 per cent lymphocytes.

March 17: The patient felt much better, and the adenopathy began to recede. The spleen was no longer palpable. The abdominal pain and the pain in the muscles and joints diminished in intensity. The white cell count was 15,800, with 35 per cent polymorphonuclear leukocytes and 65 per cent lymphocytes.

March 18: The white cell count was 11,600, with 30 per cent polymorphonuclear leukocytes, 67 per cent lymphocytes and 3 per cent eosinophils. He was up and walking about and felt greatly improved.

March 21: The patient was discharged. The temperature was normal. The red cell count was 5,630,000, with 94 per cent hemoglobin (Sahli). The white cell count was 9,700, with 49 per cent polymorphonuclear leukocytes, 48 per cent lymphocytes, 2 per cent eosinophils and 1 per cent basophils. The lymphocytes were of the usual small variety, with only an occasional vacuolated, enlarged one.

SUMMARY

The foregoing case is presented, first, because of the confusion introduced by the history of injury to the skull and, second, because of the rare feature of bilateral papilloretinal edema.

Laboratory Data on a Patient with Infectious Mononucleosis

	3/5/49	3/7/49	3/10/49	3/15/49	3/17/49	3/18/49	3/21/49
Red blood cell count	4,910,000	..	..	5,310,000	5,910,000	5,970,000	5,020,000
White blood cell	7,050	5,070	13,250	10,300	15,800	11,800	9,700
Hemoglobin, %	104	..	..	104	94	94	94
Polymorphonuclear leukocytes, %							
Neutrophils, %	40	50	11	15	35	30	49
Eosinophils, %	1	2	..	..	..	2	2
Basophils	..	..	..	..	..	..	1
Stab forms, %	..	..	..	2	..	..	..
Lymphocytes, %	47	46	85	75	65	67	48
Monocytes, %	9	2	4	8	..	..	..

Bone marrow, Hyperplastic (3/15/49):

Polymorphonuclear leukocytes	21	Myelocytes	47	Lymphocytes	286	Normoblasts 28
Stab forms	34	Eosinophilic	4	Lymphoblasts	5	Erythroblasts 1
Metamyelocytes	31	Basophilic	4	Monocytes	4	
		Myeloblasts	1			

Total cells counted: 300

Spinal Fluid: Cell count, 6 per high power field: 66 lymphocytes; 35 polymorphonuclear leukocytes
Sugar, 58 mg.; total protein, 51 mg.; chlorides, 710 mg. per 100 cc.
Culture: No growth; no acid-fast bacilli

Urinalysis: Specific gravity, 1.018; albumin, 0; sugar, +2; white blood cells, occasional

The history suggested the possibility of chronic subdural hematoma. The laboratory data and subsequent clinical behavior confirmed the diagnosis of infectious mononucleosis. Bilateral papilloretinal edema is a rarely observed manifestation of this disease.

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OCULAR FAT EMBOLISM

A Clinical and Pathologic Report

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FAT EMBOLISM has been described [1] as a condition in which fat is circulating in the blood stream in globules large enough to occlude the capillaries and induce multiple anoxic foci. Although this disease is considered something of a rarity, Scuderi [2] in 1941 stated that there were over 600 references to fat embolism in the literature. He further stated that clinically the condition was difficult to substantiate, the difficulty being due not so much to the fault of the diagnostician as to the nature of the disease.

A recent report by Fritz and Hogan [3] has indicated the rarity of ocular signs of the condition. Further investigation has revealed that, although ocular fat embolism is not so rare as has been thought, it nevertheless is distinctly unusual. Particularly is the diagnosis rarely based on pathologic study. At least 23 case reports of ocular fat embolism are readily available, 7 of which were substantiated by anatomic studies of the globe.[4] The present paper will present a case in which

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Read at the Eighty-Fifth Annual Meeting of the American Ophthalmological Society, Hot Springs, Virginia, June 3, 1949.

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1. Robb-Smith, A. H. T.; Hunt, A. H.; Russell, D., and Greenfield, J. G.: Discussion on Fat Embolism and the Brain, Proc. Roy. Soc. Med. **34**:639-656, 1941.

2. Scuderi, C. S.: Fat Embolism: A Clinical and Experimental Study, Surg., Gynec. & Obst. **72**:732-746, 1941.

3. Fritz, M. H., and Hogan, M. J.: Fat Embolization Involving the Human Eye, Am. J. Ophth. **31**:527-534, 1948.

4. Urbanek, J.: Fat Embolus of the Eye, Arch. f. Ophth. **131**:147-173, 1933; abstracted, Am. J. Ophth. **17**:383, 1934. Löwenstein, A.: Fettembolie als Ursache der Angiopathia retinae traumatica (Purtscher), Klin. Monatsbl. f. Augenh. **96**:62-71, 1936; abstracted, Am. J. Ophth. **19**:440-441, 1936. Evans, J. J.: Cerebral Fat Embolism with Recovery and Involvement of the Central Retinal Artery, Brit. J. Ophth. **24**:614-616, 1940. Bernhard, F.: Ueber Fettembolie in dem Blutgefassen des Auges, München. med. Wchnschr. **72**:1590, 1925. Walsh, F. B.: Clinical Neuro-Ophthalmology, Baltimore, Williams & Wilkins Company, 1947, pp. 1009-1012. Hosch: Fettembolie der Retina, Arch. f. Augenh. **54**:162-164, 1906. Oppolzer, R.: Die Fettembolie der Netzhaut nach Traumen, Arch. f. klin. Chir. **179**:176-210, 1934.

it was possible to make a sketch of the fundus before death and then to secure a complete necropsy.

Detailed studies of the general manifestations of fat embolism are available in the publications of Groskloss,[5] Vance [6] and Scuderi.[2] Therefore only the essential features will be reviewed.

Although there is no doubt that gross trauma is the most frequent causative factor, fat embolism has been found as a complication of burns, surgical manipulation of joints, therapeutic injection of oily substances, injection of paraffin into the orbit [7] as a reparative procedure and poisoning by ammonia and other alkalis. Fracture of one or more of the long bones is oftenest the chief traumatic lesion. Although a considerable degree of hyperlipemia may often be associated with diabetes and other systemic diseases, symptoms of fat embolism do not appear, presumably because the fat globules are present in the form of a fine emulsion. Agreement is still not complete as to the source of the fatty material and the mode of its entry into the circulation, but it is most generally assumed that the fat of the bone marrow enters the venous system through torn, open veins, which are kept mechanically open by their presence in the firm haversian canals of the long bones.

The clinical picture may vary from total absence of signs to rather rapid death, the type depending (*a*) on the amount of fat entering the circulation and (*b*) on whether or not most of the fat is held back in the lungs. If the fat enters the arterial circulation, the brain, heart and other organs are then involved. In the pulmonary form of the disease, the sequence of events is usually (1) an accidental injury associated with fracture of a long bone, often with delay in immobilization; (2) an initial period of shock with recovery, followed by a generally satisfactory condition lasting from several hours to a day, and (3) after a premonitory period of vague pains in the limbs, a sense of thoracic constriction and dyspnea and the appearance of symptoms of acute pulmonary edema. In perhaps one third of the cases pulmonary signs either do not appear or are trivial, the major manifestations being cerebral. In such cases the sequence of events is (1) trauma, (2) a free interval of from two to three days, during which the patient is apparently convalescing normally, and (3) rather rapid onset of a symptom complex, consisting of delirium, stupor, coma, hyperpyrexia

5. Groskloss, H. H.: Fat Embolism, Yale J. Biol. & Med. **8**:59-61 and 175-197, 1935; 297-316, 1936.

6. Vance, B. M.: The Significance of Fat Embolism, Arch. Surg. **23**:426-465 (Sept.) 1931.

7. Hurd, L. M., and Holden, W. A.: A Case of Paraffin Injection into the Nose Followed Immediately by Blindness from Embolism of the Central Artery of the Retina, M. Rec. **64**:53-55, 1903. Uhtoff, W.: Injury to the Eyes After Paraffin Injections for Saddle Nose, Ophth. Rec. **15**:115-117, 1906.

and absence of signs of a localizing nature. The presence of petechial hemorrhages in the skin is often a helpful diagnostic sign.

General pathologic examination [8] frequently reveals fat emboli in the systemic organs, and it is quite possible that routine pathologic study of the eyes would show such changes. Löwenstein and Foster [9] have indicated that frequently it is not difficult for fat globules to enter the eye. The rarity of ocular embolism, then, is possibly attributable to several causes. 1. The cerebral form of the disease, with widespread dissemination of the globules, is uncommon. 2. Ophthalmoscopic examination is not likely to be requested unless cerebral changes are obvious. 3. Fat may be present in the retinal vessels without changes in the fundus being detectable, as borne out in the present case and demonstrated by Urbanek. The statement of Groskloss that normal fundi do not speak against the possibility of fat embolism is well taken. Von Czerny [10] injected fatty material into the jugular vein of dogs. On the next day congestion of the retinal veins and edema of the retina were observed. It was not until one to seven days later that the picture took on the form of preretinal hemorrhages. It is probable that a certain period of delay may occur between the actual lodging of the embolus and the development of ophthalmoscopic evidence.

REPORT OF A CASE

Clinical Study.—C. S., a man aged 25, was struck by an automobile on November 22 at about 6 p.m. He remained fully conscious, alert and cooperative but received the following injuries: (1) multiple, compound, comminuted and simple fractures of both tibias and fibulas; (2) fracture of the eleventh rib on the right side, and (3) fracture of the transverse processes of the first to the fourth lumbar vertebrae, inclusive. There was no head injury. Shortly after the accident the patient was hospitalized, and the wounds were cleaned and the legs placed in fracture boxes.

On November 23 at 12:30 p.m. the patient was examined and found to be in sufficiently good condition to warrant his transfer to another hospital. At 2 p.m., while in an ambulance and without being subjected, so far as is known, to any additional trauma, he suddenly became comatose and his pulse rapid and fleeting. Forty-five minutes later, after reaching the hospital, he was found to be in deep coma, with Cheyne-Stokes respiration. He was cyanotic, and his skin was covered with many petechiae, which subsequently increased in number. The temperature was 102 F., the pulse rate 110, the respiration rate 24 and the blood pressure 126 systolic and 60 diastolic. The pupils were pinpoint, and the eyeballs occasionally rolled irregularly. Numerous petechial hemorrhages were present in the palpebral and bulbar conjunctivas of each eye. There was no bleeding from the ears, nose

8. Wright, R. B.: Fat Embolism, Ann. Surg. **96**:75-84, 1932.

9. Löwenstein, A., and Foster, J.: Fatty Embolism of the Retinal Artery Found in Eyes After Enucleation and Orbital Exenteration, Brit. J. Ophth. **32**:819-823 (Nov.) 1948.

10. von Czerny: Ueber die klinische Bedeutung der Fettembolie, Berl. klin. Wchnschr. **12**:593 and 605, 1875.

Fig. 1.—Fundus of the right eye eighteen hours before death.

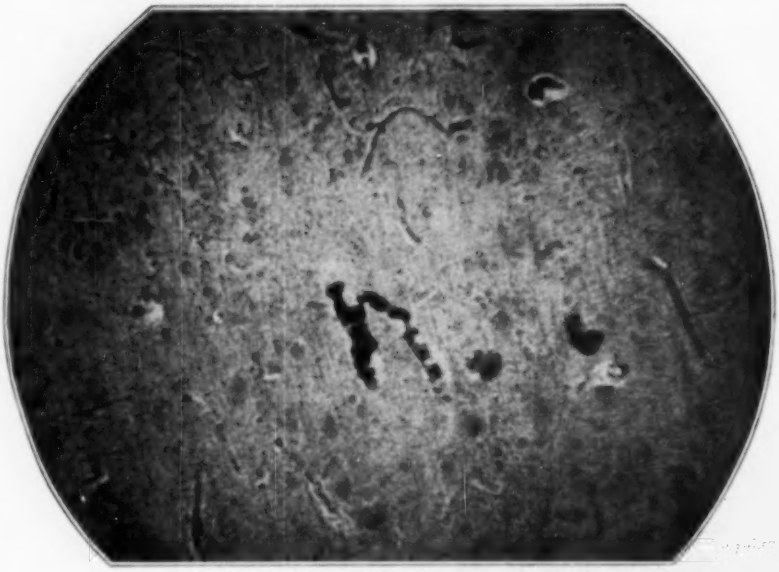

Fig. 2.—Fat emboli in the cerebral vessels.

Fig. 3.—Fat emboli in the ciliary processes.

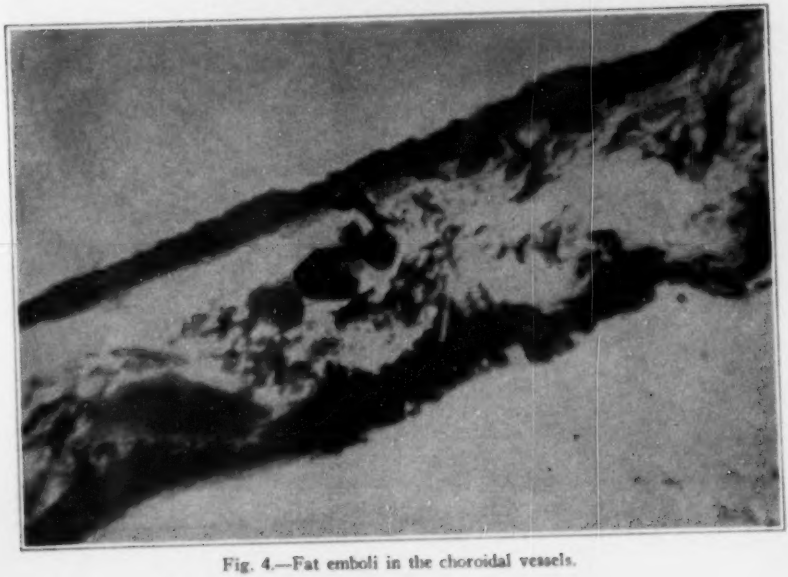

Fig. 4.—Fat emboli in the choroidal vessels.

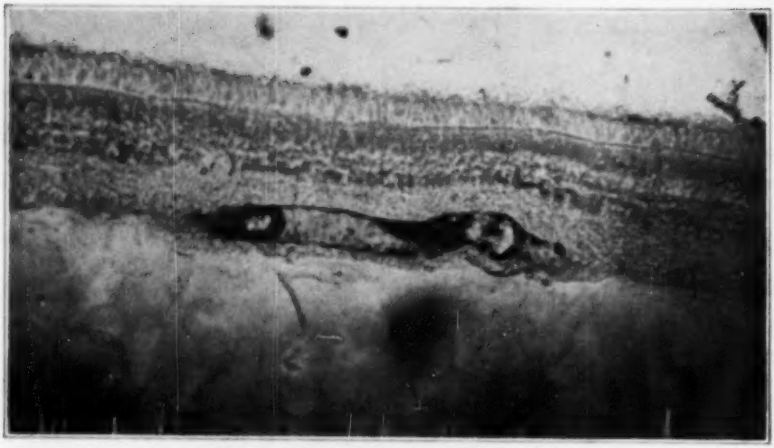

Fig. 5.—Fat emboli in the retinal vessels.

Fig. 6.—Fat emboli in the optic nerve.

or pharynx. The thorax was regular, and the lungs appeared normal on auscultation. No cardiac abnormalities were noted other than sinus tachycardia. The abdominal findings were not unusual. There was complete muscular flaccidity with absence of tendon reflexes. The blood and urine were normal, but since the condition was not suspected at first studies for fat were not made. Roentgenograms confirmed the presence of multiple fractures.

The patient received the usual supportive treatment, with transfusions of whole blood and injections of gas gangrene antitoxin and penicillin. Because of his precarious condition, no change in the immobilization of his legs was made. Cardiac arrhythmia became total, and, after a continuous downhill course, he died on November 25 at 3:50 a.m., about thirty-six hours after his admission to the hospital and two and one-half days after his original injury.

Examination of the eyes was made about eighteen hours before his death. Petechial hemorrhages were noted in the bulbar and palpebral conjunctivas of both eyes, but there was nothing suggestive of local injury. The pupils were dilated for study of the fundus. In the right eye, the disk was normal, and no gross abnormalities could be detected in the retinal vasculature. At the macula a typical cherry red spot was present, surrounded by an area of edema. Adjacent to this were six discrete, fluffy exudates of the fresh cotton wool type. No hemorrhages were present. A rough sketch of the fundus was made, which Mr. Gustav Bethke later used for his completed drawing (fig. 1). In the left eye there were comparable changes, although a careful search was made.

Pathologic Examination.—Complete autopsy (Capt. Helmuth Sprinz, Medical Corps, Army of the United States) showed venous engorgement and fresh interstitial hemorrhages in all the organs. Staining with scarlet red revealed massive fat embolism of the capillaries and venules in all organs, as well as fat globules within the alveoli of the lungs and the lumens of the renal tubules (fig. 2).

Both eyes were fixed in gelatin, sectioned and stained with oil red, scarlet red, osmic acid and hematoxylin and eosin. The changes were quite similar in the two eyes, evidence of intravascular fat-staining material being abundant. The cornea, angle of the chamber and iris presented no abnormalities. The ciliary body was normal, no stained fat being seen in the substance of the ciliary body itself. However, several ciliary processes showed unmistakable occlusion of the vessels (fig. 3). Throughout the extent of the choroid, but most conspicuously at the posterior pole, globules of fat were irregularly encountered (fig. 4). Similarly, the retina presented numerous, usually superficially situated, vessels which were occluded with fat (fig. 5). These were more frequent at the posterior pole, but were also found anteriorly. In several instances occluded vessels were noted, surrounded by patches of disorganized, edematous retina This condition was particularly conspicuous around the macula of the right eye and represents the cotton wool patches seen ophthalmoscopically. The nerve heads were normal, but fat was present in the vessels of the optic nerve (fig. 6).

SUMMARY

A review of the literature, which was by no means exhaustive, revealed that fat embolism of the human eye is not so rare as has previously been considered. A case is reported in which it was possible to sketch the fundus before death and then to secure a complete necropsy.

BILATERAL ANTERIOR AND RUDIMENTARY POSTERIOR LENTICONUS

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ANOMALIES in the curvature of the anterior surface of the transparent lens, called anterior lenticonus, or lentiglobus, are rare. The case presented here is unique in the literature, since it shows a rudimentary posterior lenticonus and a typical anterior lenticonus (lentiglobus). The case was presented at a meeting of the Greek Ophthalmological Society in March 1949.

Before the condition is described, the cases reported in the literature under the name of anterior lenticonus, or lentiglobus, will be briefly reviewed. It will be explained also why some of these cases do not belong strictly to the category under discussion.

Webster [1] (1875) was the first to describe, under the name of anterior lenticonus, the condition of a man aged 24 who had a conic change in the region of the anterior pole of both lenses. There also existed a posterior polar cataract.

The second observation, erroneously attributed to van der Laan, had been published by Plácido [2] in 1880. It concerned a young man with a conic deformation of the anterior pole of each lens. The central part of the clear lenses was highly myopic, whereas the periphery showed a hypermetropia of +3 D. The visual disturbance had begun eight years before.

The third case was published by Venneman [3] in 1891. It pertained to a woman aged 20 who five years earlier, with the beginning of menstruation, had noticed dimming of her vision. Examination revealed anterior lenticonus in both eyes. The lenses were transparent and were myopic in the center and hypermetropic at the periphery.

1. Webster, D.: Ein Fall von Lenticonus aus der Praxis des Dr. C. R. Agnew, Arch. f. Augenh. **4**:262-264, 1875.

2. Plácido, A.: Uma nova anomalia de conformação do cristalino: cristalócone polar anterior, Periód. de Ophth. Prat., Lisbon **2**(nos. 3-4):41; **2**(nos. 5-6):30, 1880.

3. Venneman, E.: Un cas de lenticône double antérieur, Ann. d'ocul. **105**:158-164, 1891.

Jaworski [4] described the fourth case in 1904, that of a man aged 32 with chronic nephritis and uremia, who several years earlier had become aware of decrease in vision. Both lenses were transparent and had a spherical projection of the anterior surface, easily visible with indirect illumination. The myopia of the central part measured —30 D.; the hypermetropia at the periphery, +3.00 D. The fundus showed albuminuric retinitis. Eight months later, at a second examination, the spherical projection in the lens of the right eye had disappeared, leaving in its place an opacity in the anterior cortex. The projection in the lens of the left eye was much smaller. The author ascribed the formation of the lentiglobus to hydrops of the epithelial cells of the lens caused by the renal disease.

The fifth case is an anatomicopathologic study of a 4 month fetus described by Seefelder and Wolfrum [5] in 1907. They noted that the capsule of the lens had a hemispherical projection, separated from the regular fibers of the lens. The space between the capsule and the lenticular fibers was occupied by a barely visible, fine, granular substance. The authors designated this anomaly as anterior lenticonus, without excluding the possibility of later absorption of the granular matter and reapposition of the capsule to the lens.

Krusius [6] presented the sixth case in 1910. The patient had a traumatic subluxation of the lens of the right eye without other change. The lens of the left eye showed a regular and distinctly circumscribed transparent projection near the anterior pole.

The seventh case, published by Mohr [7] in 1910, concerned an anatomicopathologic observation on a 5½ month old child with hydrophthalmos. On the anterior surface of the lens was an irregular conic projection. On the top of the conus the capsule of the lens was absent, and in the corresponding part of the cornea the posterior elastic layer (Descemet's membrane) presented a similar defect. Between the lenticonus and the cornea was a homogeneous substance. Microscopically, however, the lens did not touch the cornea.

Frey [8] in 1922 described the eighth case. The original paper was not available, but the report was supposedly concerned with a typical

4. Jaworski, A.: Ein Fall von Lenticonus anterior und über dessen Entstehen, Arch. f. Augenh. **65**:313-317, 1910.

5. Seefelder and Wolfrum: Ueber eine eigenartige Linsenanomalie (Lentiglobus anterior) bei einem viermonatlichen menschlichen Fötus, Arch. f. Ophth. **65**:320-325, 1907.

6. Krusius, F. F.: Ueber zwei seltene Anomalien des Linsensystemes, Arch. f. Augenh. **65**:233-238, 1910.

7. Mohr, T.: Ein Beitrag zur Pathogenese des Lenticonus anterior, Klin. Monatsbl. f. Augenh. **48**:157-167, 1910.

8. Frey, L.: Einige Fälle interessanter Linsenveränderungen, Arch. f. Augenh. **90**:135-146, 1922.

case of bilateral lenticonus in a young person with nephritis. Frey, unlike Jaworski, did not accept the idea of a relation between the anomaly of the lens and the nephritis.

The ninth case, published by Riedl [9] in 1923, was that of a man aged 36 with diminishing vision who presented typical bilateral anterior lenticonus with myopia of —7.00 D. in the central part of the lens. Weiss [10] described the tenth case in 1927. Although the original text was not obtainable, the case was obviously one of typical bilateral anterior lenticonus.

In 1929 Kienecker [11] published the eleventh case. A man aged 42, with chronic nephritis and high blood pressure, had noted progressive diminution in vision for ten years. Examination of the eyes disclosed typical bilateral anterior lenticonus with myopia of —20.00 D., in the center of the lens and hypermetropia at the periphery. This patient was the first to be examined with the slit lamp. The lenticonus contained transparent lens substance; the zone of separation, following closely the curvature of the anterior surface of the lens, participated in the spherical projection. The nucleus did not take part in the projection. Kienecker saw no relation between the anomaly and the renal disease

The twelfth case, published by Feigenbaum [12] in 1929, was that of a 10½ year old boy who complained of decreased vision and had typical bilateral lenticonus with central myopia of —5.50 D. Examination with the slit lamp proved that the cone, in addition to a small number of fine opacities, contained transparent lens material and that the peripheral zone of the embryonic nucleus did not participate in the projection. On examination two years later, Feigenbaum observed a slight increase in the central myopia (—7.00 D.), and consequently an increase in the lenticonus.

In both Kienecker's and Feigenbaum's cases, examination with the slit lamp proved (*a*) that the lens capsule was intact, (*b*) that the projection had its base exactly in the center of the surface of the lens and contained transparent lens substance and (*c*) that the projection was limited to layers of the lens which are formed in postembryonic life.

Lastly, in 1948 Sen [13] published the thirteenth case of anterior lenticonus. A boy of 14 years complained of decreasing vision in his right

9. Riedl, A.: Lenticonus posterior; Lenticonus anterior, Klin. Monatsbl. f. Augenh. **71**:344-348, 1923.

10. Weiss, A.: Ein Fall von vorderem Lenticonus, Russk. oftal. zhur. **6**:281-285, 1927.

11. Kienecker, R.: Ueber einen Fall von doppelseitigem sogenanntem Lentiglobus anterior, Klin. Monatsbl. f. Augenh. **82**:55-64, 1929.

12. Feigenbaum, A.: Lentikonus anterior, Klin. Monatsbl. f. Augenh. **83**:35-37, 1929.

13. Sen, K.: Anterior Lentiglobus: Atypical Case, Brit. J. Ophth. **32**:305-311, 1948.

eye. A small, oval, circumscribed, partly clouded projection was present on the anterior surface of the lens. This projection, having the form of a hernia, was located in the periphery of the lens and consisted of anterior cortex; its surface was irregular, and the capsule was thinnest here. The lens in the left eye showed no anomaly.

REPORT OF A CASE

A. B., a farmer aged 25 from Crete, came to the ophthalmologic clinic of the Piraeus State Hospital on Jan. 20, 1949. He stated that he had attended school regularly and had been able to see well until the age of 20. From that time he had noted progressive diminution in vision, which had recently caused him great difficulty in reading.

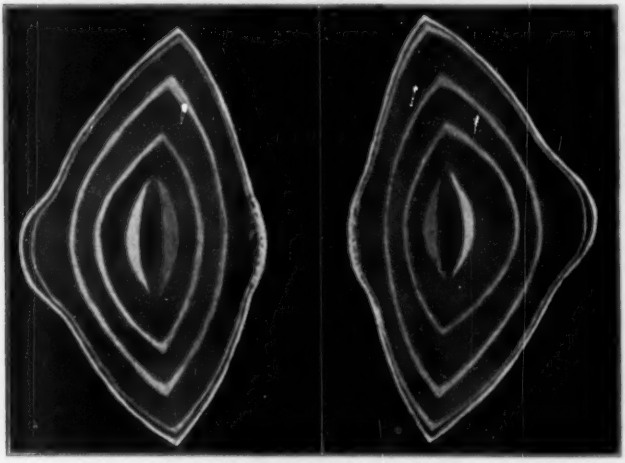

Fig. 1.—Photographs (left row) of the left eye and (right row) of the right eye taken with slit lamp illumination, showing anterior and posterior lenticonus.

Ophthalmologic Examination.—External examination showed no pathologic changes. Ophthalmometric readings of the cornea were as follows: right eye, 47.5 D. in the vertical meridian and 47 D. in the horizontal meridian; left eye, 48 D. in the vertical meridian and 47.5 D. in the horizontal meridian. Transillumination with the plane mirror presented a picture suggestive of an oil drop placed on the lens in the center of the pupil in each eye. In this area was no trace of cloudiness. By small movements of the mirror, shadows could be elicited similar to those of keratoconus. Retinoscopy with atropine gave the following results: right eye, —12.0 D. in the center, with emmetropia at the periphery; left eye, —14.0 D. in the center, with emmetropia at the periphery. Vision in the right eye was 1/10 (improved to 4/10 with the stenopeic pinhole and a correcting lens of — 12.0 D.); left eye, 1/20 (improved to 3/10 with the stenopeic pinhole and a correcting lens of —14.0 D.).

Examination with the Slit Lamp.—In the central region of the anterior surface of the lens was a clearly defined spherical projection. It had a diameter of about 2.5 mm., was located at the anterior pole (of the lens) and contained transparent lens substance. With the narrow beam of the slit lamp the capsule was found to be intact. The anterior separating zone followed the anterior capsule in a parallel, regular bow. The projection contained transparent anterior cortex. The nucleus did not take part in this change.

With a higher magnification, a thin layer of fine opacities was noted in the bulge lying close under the anterior capsule. The posterior surface of the lens showed, at the posterior pole, a rudimentary, but well defined, spherical projection of the intact capsule, which contained the transparent posterior cortex. This

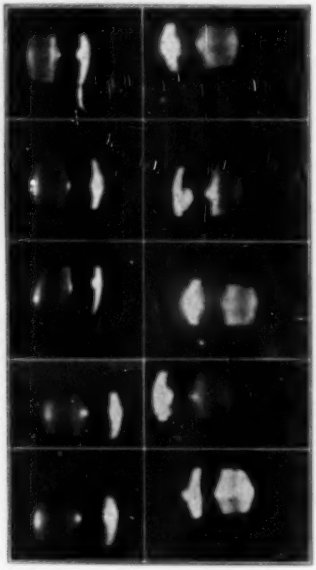

Fig. 2.—Drawing of the lens (left) of the right eye and (right) of the left eye made with slit lamp illumination.

change was accentuated in the left lens. Nasal to the posterior pole of the lens, and within the small spherical projection, physiologic remnants of the hyaloid artery were clearly visible. Figure 1 shows the photographs obtained with a "contax" camera equipped with "panflex" film, using slit lamp illumination. Examination of the fundus disclosed a few small areas of choroidal atrophy between 6 and 9 o'clock in the periphery of the right eye. Tension was normal in each eye. General examination of the patient, as well as laboratory tests, revealed nothing abnormal.

It was not possible to examine the parents and the three brothers of the patient, as they lived in Crete. However, none of the relatives had complained of decreased vision, nor had any of them suffered from ocular disease.

COMMENT

Of the 13 cases in the literature, only those of Webster, Plácido, Venneman, Frey, Riedl, Weiss, Kienecker and Feigenbaum can be considered true examples of anterior lenticonus. The other 4 cases were most likely concerned with anomalies of the lens of a different nature. The points on which this opinion is based are as follows:

Seefelder and Wolfrum's observation was made on a 4 month old fetus. The histologic description refers to a projection of the anterior capsule. Since the further development of this anomaly could not be foretold, classification is impossible. The authors themselves considered the possibility of regression of the anomaly if the fetus had lived. The case of Mohr also concerned the histologic picture of the eye of a 5½ month old baby. Among other ocular changes, the lens had an irregular shape, not sufficiently characteristic for the diagnosis of a conus. The case of Krusius is doubtful because the conic projection was not located in the central part of the anterior surface of the lens, and it seemed to extend in the shape of a tube to the depth of the lens. The case of Sen, considered by the author himself as atypical, must also be excluded. The projection of the anterior cortex of the lens in the form of a hernia and the defect of the anterior capsule were probably due to old trauma. This explanation was also suggested by Ida Mann. The case of Jaworski is the strangest and most unique in the literature dealing with this anomaly. The lenticonus, which caused a central myopia of —30.00 D., receded almost completely after eight months, leaving in its place a small opacity of the lens. It is difficult to agree with the author, who expressed the belief that the formation of the lenticonus was due to hydrops of epithelial cells of the lens caused by chronic nephritis. Nephritis does not produce intense local hydrops. The disappearance of the lenticonus in eight months does not fit into the picture of this anomaly, although the reliability of the evaluation must be discounted, since the slit lamp technic was not then available.

The present case was that of a young man in good health with bilateral typical anterior lenticonus and a rudimentary posterior one. To our knowledge, this observation is the first reported in the literature in which anterior and posterior lenticonus coexisted. The rudimentary, but clearly discernible, posterior lentiglobus differed from the well known and frequently described condition with this name. The latter always shows a definite opacity. It is generally thought to be a congenital anomaly resulting from a rupture of the posterior capsule in the embryonic period. In the present case, the posterior lentiglobus had a shape similar to the anterior lesion, contained transparent cortex and was covered by an intact capsule.

This anomaly cannot be considered as congenital for the following reasons: (*a*) The patient had perfect vision until he was 20 years old.

at which time he noted a decrease in acuity, and (*b*) examination of the lenses with the slit lamp revealed that the anterior, as well as the rudimentary posterior, lenticonus in each eye consisted of transparent cortex without any participation of the nucleus.

Opinions differ regarding the time of appearance of this lenticular anomaly. Some authors have asserted it to be a congenital defect. Others have expressed the opinion that the change of curvature on the anterior surface of the lens appears later, in the adolescent period.

The view of the congenital origin was held by Webster, Frey, Riedl and Weiss, who did not specify the time of appearance of the visual disturbance but whose patients were adults. The theory of the acquired character of the anomaly was offered by Plácido, Venneman, Kienecker and Feigenbaum. The literature to date does not provide sufficient evidence for a final conclusion. Present knowledge of the embryology of the lens does not contribute to a clear explanation of the anomaly. The observations in the present case, as well as those provided by four of the authors cited, strongly suggest that this defect can be acquired. Such an opinion is further supported by the fact (1) that similar lesions have not been described in children of preschool age, and (2) that all studies with the slit lamp have shown that the nucleus of the lens did not take part in the spherical projection.

The etiology and pathogenesis of the anterior lenticonus remain unknown. The localization and the form of the defect may lead us to suspect that the accommodation plays a part in the formation of the lenticonus.

THE PUPILLARY FUSION REFLEX

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IN 1936 Schubert and Burian [1] published their discovery of the pupillary fusion reflex (*Fusionreaktion*), which was defined as a dilatation of the pupil with a disruption of fusion and, conversely, a constriction of the pupil with its resumption. This reflex was stated to be not evanescent but lasting. Since that time no further report has been published on the subject.

During an investigation of the pupillary near reflex [2] the question that the fusion reflex may be an artefact arose. In finding the relationship of pupillary diameter to accommodation and the various components of convergence, as originally divided by Maddox [3] and quantified by others,[4] we determined that the pupillary near reflex is essentially elicited by accommodation. Fusional convergence plays a minor role in some subjects but none at all in others. A psychic proximal factor in the pupillary near reflex was indicated, but it is of no quantitative importance. Another concurrent, but independent, investigation of the same subject has supported these findings completely.[5]

The question was: Could the fusion reflex be simply a manifestation of the pupillary near reflex because of a lack of complete control of accommodation and convergence? An attempt was made to elicit the fusion reflex with accommodation, convergence, illumination and all other factors which affect the pupil controlled as carefully as possible.

From the School of Optometry, University of California.

1. Schubert, G., and Burian, H.: Die Fusionreaktion, ein bisher unbekannte Reaktion der Pupille, Arch. f. d. ges. Physiol. **238**:184, 1936.

2. Marg, E., and Morgan, M. W., Jr.: The Pupillary Near Reflex: The Relation Between Pupillary Diameter, Accommodation and the Various Components of Convergence, Am. J. Optom. **26**:183, 1949.

3. Maddox, E. E.: The Clinical Use of Prisms, and the Decentering of Lenses, ed. 5, London, Simpkin [and others], 1907, pp. 158-171.

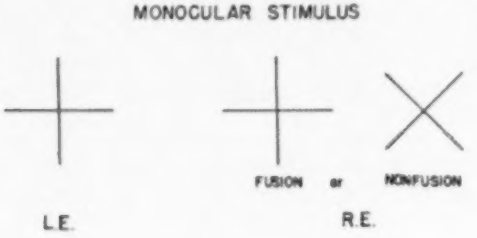
4. Fry, G. A.: An Experimental Analysis of the Accommodation-Convergence Relation, Am. J. Optom. **14**:402, 1937; Further Experiments on the Accommodation-Convergence Relationship, Tr. Am. Acad. Optom. **12**:65, 1938. Hofstetter, H. W.: The Proximal Factor in Accommodation and Convergence, Am. J. Optom. **19**:67, 1942. Morgan, M. W., Jr.: Accommodation and Its Relationship to Convergence, ibid. **21**:183, 1944.

5. Knoll, H. A.: Am. J. Optom. **26**:346, 1949.

If no reflex could be found on the disruption and on the resumption of fusion with these controls, then it would be concluded that the fusion reflex is an artefact.

APPARATUS

The instrument was basically a haploscope, which has been well described in the literature.[6] Several modifications were made. The right arm had its customary Badal optometer with a red point source of light for the object, but on the left, for pupillometry, was mounted a 35 mm. camera with an extension lens mounting so that an actual size infra-red picture could be taken of the left eye through the half-reflecting mirror when the subject was properly alined in the instrument. The exposure was 0.1 second for the ostensibly f 2.8 lens. A millimeter rule was



The monocular stimulus is shown for the left eye (*L. E.*) in its fixed position and for the right eye (*R. E.*) in the fusion position and, by a 45 degree rotation, in the nonfusion position. When the stimulus for the right eye is in the fusion position, the binocular percept is a simple cross. When the stimulus for the right eye is rotated to the nonfusion position, the binocular percept is the combination of the vertical-horizontal cross stimulus of the left eye and the oblique cross stimulus of the right eye. In the latter position there is no fusion. The crosses are actually white on a black background, and not black on white, as in the diagram.

photographed in the apparent plane of the iris, and this was later projected to exactly ten times its original physical size. Then the pupillary diameter was readily measured to 0.1 mm. The infra-red light source placed near the left arm of the haploscope directed a slightly out of focus image of the lamp filament to the left eye by way of a plane mirror. A water cell placed behind the converging lenses absorbed the far infra-red radiation to the degree that the subject was not

6. Ames, A. Jr., and Gliddon, G. H.: Ocular Measurements, Tr. Sect. Ophth., A. M. A., 1928, p. 102.

aware of the heat from this source. A Wratten no. 87 filter allowed only a slight red glow to be seen, and it was a constant and peripheral one. The 900 watt projection bulb was run at 700 watts because it thus gave a rich source of the desired near infra-red radiation without overheating the filters.

Field stops, a diamond-shaped one on the right and a square on the left, similar to those of the eikonometer, were used to prevent peripheral fusion, although the room was so dark that most subjects were not aware of them.

Dual projectors were focused on an aluminum screen, which was 5 meters from the subject. A white cross was imaged by the left projector; a similar cross was imaged by the right one. The right hand cross was mounted so that it could be rotated through an angle of 45 degrees. The polaroid filters before the projectors and the subject's eyes limited the image in the right eye to the cross of the right projector and the image in the left eye to the cross of the left projector. The rotation of the right cross made it possible to present fusible or nonfusible targets as desired, as illustrated in the chart. The bars of the crosses measured 97 by 2.7 cm. and had an effective luminance of 2½ foot candles before traversing the polaroid® filters at the haploscope.

The shutter and the rewind of the camera were remotely controlled from the right side, where the experimenter could read the optometer scale and change the target from the fusion to the nonfusion position and vice versa without disturbing the subject.

PROCEDURE

Nine of the 11 subjects were junior students in the School of Optometry of the University of California. They had no previous experience as observers in haploscopic experiments and had no preconceived idea as to what the experiment should show. The other two were graduate students with considerable experience with haploscopic work. All the untrained observers were given a training period, which consisted of a general explanation of the apparatus and a regular experimental run except for the absence of film in the camera. This familiarized them with the apparatus, and they became accustomed to the unavoidable stimuli, such as the noise of the rewinding of the camera, which in some subjects affect the size of the pupil.

Before beginning an experimental run, the subject was alined with the instrument; the target was rotated to the nonfusion position, and prisms were placed before the right eye in the lens cells of the haploscope until the subject reported that the centers of the two crosses were superimposed. At no time was there fusion of these centers alone, because the subjects reported changes in relative target position with as little as ¼ △ change of stimulus horizontally. The superimposing prism gave a measurement of the heterophoria (for the 5 meter target distance), but, more important, it allowed the eyes to be in their fusion-free position, or position of functional rest, even after the target had been rotated to the fusion position and sensory and integrative fusion had taken place. Hence no movements of the eyes took place with change of the target from the fusion to the nonfusion position or vice versa because the eyes were constantly in the motor fusion position.

Illuminance was constant, and a change in position of the targets was used to elicit and disrupt integrative fusion. Retinal illuminance would be constant except for changes in pupillary size.

Four sets of five determinations each were taken, the sets starting with the target in the fusion position and alternating with it in the nonfusion position. As he fixated the center of the cross (fusion position), the subject set the optometer,

immediately after which the camera shutter was released, the camera rewound, the optometer reading recorded and the cycle repeated for a total of five times. Then the target was rotated 45 degrees to the nonfusion position, and five more determinations were taken. The determinations were repeated with fusion, and again with nonfusion, until the twenty determinations were completed.

The five determinations of each set were averaged both for accommodation (relative to the primary principal plane of the eye) and for apparent pupillary diameter. Also, the mean values for the fusion positions (first and third sets) and for the nonfusion positions (second and fourth sets) were found separately.

TABLE 1.—*Results of Determinations, with Arithmetical Means and Their Differences, for 11 Subjects*

Subject	R. H.	W. F.	P. J. B.	F. J.	P. F. B.	B. G.	A. C.	H. S.	R. E.	G. C.	D. L.
Pupilary diameter, mm.											
First set											
Fusion (F_1)	5.78	6.22	8.20	6.95	7.14	7.48	8.58	7.74	5.56	6.86	7.29
Nonfusion (N_1)	5.81	6.08	8.08	7.02	6.53	6.06	8.37	8.12	4.94	6.54	6.96
$N_1 - F_1$	−0.27	−0.14	−0.14	0.06	−0.61	−1.42	−0.06	0.38	−0.60	−0.34	−0.40
Second set											
Fusion (F_2)	5.10	6.02	7.90	6.98	6.54	5.96	8.29	6.40	4.44	6.24	6.60
Nonfusion (N_2)	5.20	5.98	7.68	6.92	6.78	5.56	8.24	7.56	4.78	6.48	6.80
$N_2 - F_2$	0.10	−0.04	−0.22	−0.06	0.24	−0.40	0.04	0.96	0.34	−0.06	0.20
Mean of sets											
Fusion (F)	5.44	6.12	8.05	6.97	6.84	6.72	8.29	7.07	4.99	6.71	6.99
Nonfusion (N)	5.23	6.03	7.87	6.97	6.66	5.81	8.28	7.74	4.86	6.51	6.89
$N - F$	−0.21	−0.09	−0.18	0.00	−0.18	−0.91	−0.01	0.67	−0.13	−0.20	−0.10
Mean for all subjects											
$N_1 - F_1$	−0.14	....	....	....	....	....	....	....	....	....	....
$N_2 - F_2$	0.10	....	....	....	....	....	....	....	....	....	....
$N - F$	−0.12	....	....	....	....	....	....	....	....	....	....
Accommodation, D.											
First set											
Fusion (f_1)	−0.07	0.66	0.83	−0.26	0.70	−0.52	−0.11	−0.13	0.44	1.66	0.30
Nonfusion (n_1)	−0.04	0.60	0.80	−0.18	0.26	−0.49	0.02	−0.20	0.50	1.18	0.32
$n_1 - f_1$	0.03	−0.06	0.03	0.08	−0.44	0.03	0.13	−0.07	0.06	−0.47	0.02
Second set											
Fusion (f_2)	−0.02	0.44	0.76	−0.55	0.46	−0.49	0.08	−0.02	0.61	1.43	0.22
Nonfusion (n_2)	−0.04	0.60	0.80	−0.32	0.35	−0.54	−0.08	−0.04	0.42	1.07	0.47
$n_2 - f_2$	−0.02	0.16	0.04	0.03	−0.11	−0.05	0.00	−0.02	−0.19	−0.36	0.25
Mean for all subjects											
$n_1 - f_1$	−0.07	....	....	....	....	....	....	....	....	....	....
$n_2 - f_2$	−0.03	....	....	....	....	....	....	....	....	....	....

One was algebraically subtracted from the other. If the value for a subject was positive, it would show a fusion reflex; if zero, no fusion reflex; if negative, it would cast doubt on the positive values of similar magnitude. Such results would indicate that uncontrollable random variations were the cause of these positive and negative values of corresponding degree.

RESULTS

All the results, arithmetic means and their differences, as described in the preceding section for each subject and for all the subjects together, are given in table 1.

If the pupillary diameter in the fusion position is subtracted from that in the nonfusion position in the first pair of sets of data ($N_b - F_a$), it is found that most of the subjects show a negative value. The average for all subjects is —0.34 mm., pointing to a reflex of negligible proportions in the opposite direction of the fusion reflex, as previously defined.

However, one can say that since the fusion position was determined first, it is likely to be larger because of the newness of the beginning run and the relative excitement that accompanies it. The second pair of sets of data can in all likelihood be examined without such a reservation. Here, indeed, are found 6 positive values to 5 negative values, but when they are averaged the result ($N_d - F_c$) is an insignificant + 0.10 mm.

TABLE 2.—*Statistical Data*

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	T	T^2
F_a	3.78	6.22	8.20	6.96	7.14	7.48	8.38	7.74	5.54	6.88	7.38	75.70	5,731.30
N_b	3.38	6.06	8.06	7.02	6.58	6.06	6.38	8.12	4.94	6.54	6.98	71.91	5,171.77
F_c	3.10	6.02	7.90	6.98	6.54	5.96	8.20	6.40	4.44	6.54	6.60	68.66	4,717.68
N_d	2.90	5.98	7.68	6.92	6.78	5.88	9.54	7.36	4.78	6.46	6.80	69.78	4,869.96
T	13.34	24.30	31.84	27.88	26.99	25.06	33.14	29.62	19.70	26.44	27.76	286.07	.....
			$\Sigma(x) = 286.07$			$(\Sigma x)^2 = 81,839.91$						$\Sigma(T^2) =$	20,490.69
												Row sum	
F_a^2	14.33	38.75	67.32	48.51	51.06	56.03	70.31	59.99	30.75	47.40	54.54	528.98	.....
N_b^2	10.86	37.08	65.04	49.35	42.71	36.78	69.31	66.02	24.45	42.84	48.79	492.99	.....
F_c^2	9.64	36.30	62.49	48.79	42.84	35.58	67.32	41.02	19.76	42.84	43.63	450.21	.....
N_d^2	10.37	35.92	59.06	47.96	46.04	30.97	67.96	54.24	22.90	42.06	46.31	463.61	.....
												$\Sigma(x^2) =$	1,985.79
T^2	178.09	590.73	1014.10	777.57	726.73	625.25	1,098.59	877.64	388.29	699.34	770.90	.....	.....
												$\Sigma(T^2) =$	7,756.23

If there is no objection to the first pair of sets of data, the pupillary diameters in the fusion positions (first and third sets) may be averaged ($\frac{F_a + F_c}{2} = F$) and, similarly, the diameters for the nonfusion positions may be averaged ($\frac{N_b + N_d}{2} = N$), and the difference ($N - F$) is found to be —0.12 mm.

Accommodation cannot be a factor in these results, because in the first pair of sets of data ($n_b - f_a$) the average optometer values show a decrease of accommodation of 0.07 D., which is not significant. In the second pair ($n_d - f_c$) the decrease is merely 0.03 D. Accommodative convergence cannot play a part in the results, because it rigorously follows accommodation and there is no significant change of accommodation. Fusional convergence has no role in the findings, since the targets are optically placed at the position of functional rest, where there is no demand for this kind of convergence. Proximal convergence is ruled out, since the targets are clearly at a physical distance of 5 meters. Tonic convergence is, of course, constant.

There is no change of retinal illuminance in rotating the target from the fusion to the nonfusion position of the targets. Noises and touch stimuli are uniform for the duration of the experiment.

It now seems likely that there is no fusion reflex. However, the probability of its existence can be more rigorously determined by statistical analysis. Also, such an analysis may be designed so that any possible bias due to the change of excitement of the subject during the experimental run does not influence the rejection or lack of rejection of the statistical hypothesis.

STATISTICAL ANALYSIS OF RESULTS [7]

The null hypothesis was used, wherein the differences in pupillary diameter found with and without fusion are due to random error and thus there is no fusion reflex.

If the variance is analyzed, any systematic error or bias because of a change in the excitement of the subject can be eliminated in the test of the hypothesis, as will be presently demonstrated.

Using an analysis of the variance with the data in table 2, we must first find the total sum of the squares (total Sx^2):

$$\begin{aligned}\text{Total } Sx^2 &= \Sigma\,(x^2) - \frac{(\Sigma\,x)^2}{N}\\ &= 1,945.79 - \frac{8,1836.91}{44}\\ &= 85.82\end{aligned}$$

Next is found the sum of the squares of the subject totals (the columns):

$$\begin{aligned}\text{Subject total sum of squares} &= \frac{1}{m}\,\Sigma\,(T^2) - \frac{(\Sigma\,x)^2}{N}\\ &= \frac{1}{4}\,(7,752.23) - 1,859.97\\ &= 78.08\end{aligned}$$

Then the sum of the squares of the treatment and order totals is found (the rows):

$$\begin{aligned}\text{Treatment and order total sum of squares} &= \frac{1}{k}\,\Sigma\,(T'^2) - \frac{(\Sigma\,x)^2}{N}\\ &= \frac{1}{11}\,(20,490.60) - 1,859.97\\ &= 2.81\end{aligned}$$

This classification may be further broken down into a separate treatment sum of squares, so that the effect of order (and with it the possible bias due to the excitement of the test) is eliminated:

$$\begin{aligned}\text{Treatment total sum of squares} &= \frac{1}{2k}\left[(\Sigma\,F)^2 + (\Sigma\,N)^2\right] - \frac{(\Sigma\,x)^2}{N}\\ &= \frac{1}{22}\left[(144.38)^2 + (141.69)^2\right] - 1,859.97\\ &= 1,860.07 - 1,859.97 = 0.10\end{aligned}$$

7. Dr. Rheem F. Jarrett, assistant professor of psychology, gave suggestions on the statistical approach to this problem.

These values are arranged in table 3. The sum of the squares of the error is found most readily by the subtraction of the rest of the sum of the squares from the grand total. Simple division yields the variance (mean square).

It is of interest to note that the variance (mean square) of the subject totals (s^2_s) is much larger than the other variances. This is because the variance of the initial differences in pupillary diameter is shown here. This value will not be used because this variation has nothing to do with possible differences associated with the disruption of fusion. Also, the variance which is caused by the order is larger than the variance resulting in the treatment or error because of the bias resulting from a decrease of excitement as the test progressed.

TABLE 3.—*Statistical Results* *

Degrees of Freedom (DF)		Sum of Squares	Estimated Variance (Mean Square) ($s^2 = \frac{\text{sum of squares}}{(DF)}$)
3 { 1		2.81 { 0.10	0.94 { 0.10 = s^2_t (of treatment)
2		2.71†	1.35 = s^2_{to} (of order and treatment)
10		78.08	7.81 = s^2_s (of subjects)
30		4.93†	0.16 = s^2_e (of error)
43	Totals	85.82	

$DF_t = m - 1 = 3$ $\quad DF_s = k - 1 = 10$ $\quad DF_e = (m - 1)(k - 1) = 30$

$$F = \frac{s^2_t}{s^2_e} = \frac{0.10}{0.16} = 0.63\ **$$

* N indicates the number of subject treatments (44); k, the number of subjects (11), and m, the number of treatments (4). $N = mk$.

** For n_1 equal to 1 and n_2 to 30 degrees of freedom, this value is not significant.

† Found by difference.

The F test (table 3) may now be applied at the 95 per cent confidence level and the result is not significant; that is, we fail to reject the hypothesis.

It is now evident that there is no pupillary fusion reflex with the experimental conditions described when "fusion" is used in the sensory or in the central integrative sense. It would appear that the announced discovery of a pupillary fusion reflex [1] was based on an artefact, presumably resulting from such factors as unsatisfactory control of accommodation, convergence and illuminance.

SUMMARY

The pupillary fusion reflex (*Fusionreaktion*) of Schubert and Burian was critically tested by a haploscopic method, using infra-red photography for pupillometry and a Badal optometer for measurement of accommodation. Dual projectors with polaroid* filters allowed separate, white cross-shaped targets to be seen by each eye. One target was

rotated 45 degrees to give nonfusible targets to the eyes without changing the retinal illuminance. The centers of the cross-shaped targets remained superimposed because prisms were used to compensate for any heterophoria for the 5 meter distance used. Differences of pupillary diameter for the fusion and nonfusion positions of the targets for 11 subjects do not indicate a pupillary fusion reflex. Statistical analysis with use of the method of analysis of variance fails to show any such reflex. It would appear that the reflex originally discovered was an artefact which may easily occur without strict control of accommodation, illuminance and convergence.

A BURIED MUSCLE CONE IMPLANT

I. Development of a Tunneled Hemispherical Type

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AND
LEE ALLEN
NEW ORLEANS

A TUNNELED hemispherical muscle cone implant and the stages in its development are described. This implant is covered completely by conjunctival tissue, thereby overcoming difficulties encountered with partially covered types. It is so designed that movement is transmitted quickly and adequately to the prosthetic eye, although there is no direct contact between the implant and the prosthesis.

DEVELOPMENT OF THE MUSCLE CONE IMPLANT

STAGE 1.—The first of the series of muscle cone implants [1] described here was used originally in April 1946. It was a variation of the basic integrated type devised by Cutler.[2] The differences were in the mechanical principles and the surgical technics involved. The implant was designed to distribute the work of support and rotation to larger areas of the rectus muscles than is possible with Cutler's implant. It (fig. 1 *A*) was 17 mm. in lateral diameter and 13 mm. in its anteroposterior dimension. A gold peg (*d*) extended forward from the anterior surface for integration with a receptacle in the prosthesis. Four tunnels (*a*) extended radially from the gold peg through the body and rounded out on the spherical surface (*c*). The opening in the anterior surface permitted the suturing of each rectus muscle to its antagonist around the peg.

After exposure of the four rectus muscles, a lock type of suture was placed on each side of the tendons approximately 1 mm. posterior to the line of insertion. The tendons were severed at their insertions, and the globe was removed in the usual manner. The implant was inserted into the muscle cone, and the muscles were pulled through their respec-

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1. Allen, J. H., in discussion on O'Brien, C. S.; Allen, J. H., and Allen, L.: Evisceration with Intrascleral Implant (New Technique), Tr. Am. Ophth. Soc. **44**:296-303, 1946.

2. Cutler, N. L.: Proceedings of the Ophthalmic Conference, Crile General Hospital, Cleveland, Ohio, November 1945.

tive tunnels. Each muscle was split lengthwise 4 mm. and brought across the center of the implant so that the split ends straddled the gold peg (fig. 1 *B*). The vertical rectus muscles were sutured together, and the horizontal rectus muscles were sutured to each other, thus forming a cross with the gold peg protruding from the center. Tenon's capsule and conjunctiva were closed over the anterior surface around the peg with a purse-string suture.

Fig. 1.—Early integrated muscle cone implant, embodying tunnels which allowed the four rectus muscles to be sutured to each other. *A*, implant: (*a*) tunnels for muscles, (*b*) opening in face for suture of muscles, (*c*) spherical posterior surface, (*d*) peg for integration with prosthesis. *B*, method of arranging and suturing muscles. *C*, schematic cross section showing implant integrated with prosthesis in relation to lids and orbit.

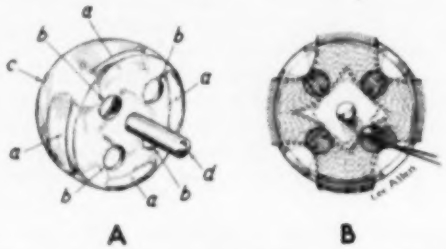

Fig. 2.—Variation of tunneled muscle cone implant, still of the integrated type. *A*, implant: (*a*) tunnels, (*b*) holes in surface to permit suture of muscles, (*c*) spherical posterior surface, (*d*) peg for integration with prosthesis. *B*, schematic drawing showing arrangement and suturing of muscles.

Approximately one month later the patient was fitted with a plastic eye. The back of the prosthesis was only slightly concave, with a hole near the center which fitted over the gold peg of the implant. Figure 1 *C* is a cross section showing the implant and prosthesis in place.

Several minor variations of this basic design were used. Figure 2 illustrates one of these. Instead of having one opening immediately around the gold peg for suturing the muscles, four smaller openings (*b*)

were placed at some distance from the peg (*d*). This arrangement of the openings was an attempt to isolate, and thus protect, the muscle tissues from contact with air and infection. Also considered was the possible advantage that less muscle tissue was required in the overlapping and suturing of the muscles. Each rectus muscle was split lengthwise about 6 mm., and only adjacent halves of the muscles were sutured to each other (fig. 2*B*). Variations in the shapes and sizes of the pegs were tried. Another arrangement of linkage between the plastic eye and the implant utilized a peg attached to the prosthesis with the receptacle for the peg in the implant, as in Cutler's original integrated implant. There seemed to be little choice between the variations. Each functioned well mechanically. A few of these various implants have been in place for three years, but most of them were retained only a few months before they were lost or removed because of secondary infection.

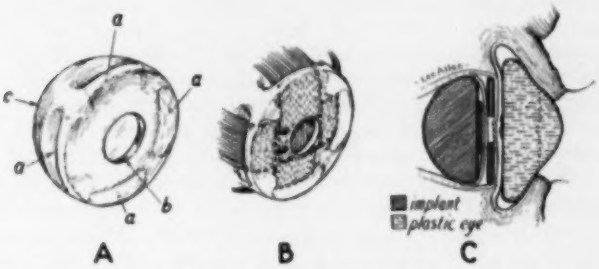

Fig. 3.—Early tunneled hemispherical, completely buried implant. *A*: implant (*a*) tunnels, (*b*) small hole in anterior surface for suture of muscles, (*c*) spherical posterior surface. *B*, method of arranging and suturing muscles. *C*, schematic cross section showing implant and prosthesis in relation to completely closed Tenon's capsule and conjunctiva and to lids and orbit.

Because of the frequency of this complication, it seemed inadvisable to continue using an implant which required an opening to be left through the conjunctiva. The peg which integrated the implant and prosthesis was the only element in the design of these implants which necessitated the opening. It was possible, therefore, to alter the design (fig. 3) so that the implant could be entirely covered by conjunctiva and yet retain the most important advantages of the partially covered integrated implant.

STAGE 2.—The peg was removed from the center of the anterior surface and this surface made perfectly flat (fig. 3*A*). A hole (*b*) 6 mm. in diameter was placed in the center of the surface for suturing the muscles. The four tunnels (*a*) were left in nearly their original position, close to the anterior face of the implant.

The rectus muscles were brought through their tunnels, as in the earlier implant, and out through the hole in the anterior surface, where the horizontal rectus muscles were overlapped and sutured and the vertical muscles overlapped, sutured and dropped back through the hole (fig. 3 *B*). Tenon's capsule and conjunctiva were completely closed in a horizontal line over the anterior surface of the implant. Figure 3 *C* shows a cross section of the implant and prosthesis in place in the muscle cone and conjunctival sac, respectively.

An ovoid plastic conformer was inserted into the cul-de-sac, in some cases a few days after the operation, and the prosthesis fitted after one month. The plastic eye was designed with a flat posterior surface which fitted the flat bed of the cul-de-sac formed over the anterior surface of the implant. Motion of the prosthesis was satisfactory, with little recognizable lag.

In the first case in which this form of the implant was used the result was entirely successful. However, in several subsequent cases the conjunctiva separated over the plastic of the anterior surface of the implant. In 1 case the dehiscence closed spontaneously after two attempts at repair and the implant was still in place approximately two years later. In another case the implant was retained for one and one-half years in spite of the continued presence of an opening in the conjunctiva, until an attempt at surgical closure was successful. All other implants in this group either were lost or were removed because of infection after treatment or because attempts at repair of the dehiscence had failed.

Stage 3.—Isolation of the conjunctiva and Tenon's capsule from living tissue was suggested as a cause of separation of the wound. Therefore, in order that these structures should be brought into contact with living tissue, the implant was redesigned (fig. 4 *A*) with a larger opening (*b*) in the anterior surface.[3] Thus, a sizable area of the overlapped muscles was exposed (fig. 4 *B*) to the inner face of the conjunctiva and Tenon's capsule. In addition, the muscle recess in the anterior surface was redesigned so that the overlapped muscles filled the space. Thus, a relatively flat plane was created at the anterior surface, much like the one in the design which immediately preceded it. The preservation of the flat plane was important to the final extent of the cul-de-sac and the transmission of motion to the prosthesis.

Because it had been found that an implant measuring 21 mm. in lateral diameter and 11 mm. anteroposteriorly could be retained even in children 18 months of age, implants of these dimensions were used for patients of all ages. This allowed the opening (fig. 4 *A*, *b*) in the anterior surface to be made 15 mm. in diameter.

3. Since preparation of this material for publication, an implant based on much the same principles has been described (Ellis, O. H.: A New Orbital Implant, Am. J. Ophth. **32**:990-992 [July] 1949).

At this time it was recognized that tension on Tenon's capsule around the edges of the implant resulting from inadequate dissection of the rectus muscles from their fascial attachments might be partially responsible for the dehiscences in Tenon's capsule and the conjunctiva. This resulted in the practice of always dissecting the belly of each rectus muscle from all attachments for at least 15 mm. and, as an added precaution, the introduction of tension sutures to hold Tenon's capsule and the conjunctiva in place in the muscle bed.

THE IMPLANT

The latest form of the tunneled buried implant (fig. 4) is basically a hemisphere 21 mm. in diameter and 11 mm. from the anterior surface to the posterior pole. An opening or recess (*b*) 1.5 mm. in depth and 15 mm. in diameter is centered in the anterior surface. Four tunnels (*a*) 1 mm. long and 9 mm. wide extend backward radially through

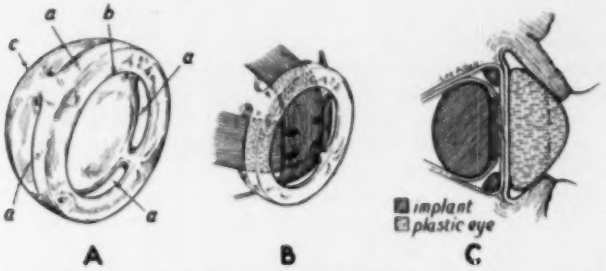

Fig. 4.—Successful variation of the buried tunneled hemispherical muscle cone implant. *A*, implant: (*a*) tunnels, (*b*) large opening in face, (*c*) spherical posterior surface. *B*, method of arranging and suturing muscles. *C*, schematic cross section showing implant and prosthesis in relation to completely closed Tenon's capsule and conjunctiva and to lids and orbit.

the body of the implant from the periphery of the recess or opening (*b*). The tunnels round gently onto the posterior spherical surface (*c*). Each of these tunnels retains one of the four rectus muscles as it passes through from the side of the spherical surface into the recess of the opening in the anterior surface, where it is overlapped with and sutured to its opponent.

The implants [4] are fabricated by hand of first grade, solid, transparent factory-processed methyl methacrylate resin.[5] Fabrication from methyl methacrylate monomer-polymer preparations is avoided to reduce the

4. Made by Precision-Cosmet Co., Inc., 234 Hennepin Avenue, Minneapolis 1.

5. This material is supplied under the trademark lucite® by E. I. DuPont deNemours & Co. (Inc.), Arlington, N. J., or plexiglas® by Rohm & Haas Co., 222 West Washington Square, Philadelphia.

possibility of burying volatile remnants, plasticizers or other impurities which might cause eventual extrusion of the implant.

SURGICAL TECHNIC

Successful use of the implants depends on the observance of five principal points: 1. The conjunctiva should be incised close to the limbus. 2. The muscle tendons should be severed as close to the sclera as possible. 3. The muscles should be separated from their fascial attachments for at least 15 mm. posterior to their severed ends. 4. Bleeding should be controlled before the implant is inserted into the muscle cone. 5. The conjunctiva and Tenons capsule should be closed without tension.

The conjunctiva is incised around the circumference of the cornea at the limbus. The conjunctiva and subconjunctival tissues are elevated, exposing the rectus muscle tendons. A single-armed 0000 surgical gut suture is placed with a lock stitch enclosing approximately one third of the width of the muscle and passing through each edge and 1 mm. from the scleral insertion of the four rectus muscles. The tendons are cut as close to the sclera as posible. The optic nerve is severed; the oblique muscles are sectioned at their insertions, and the globe is delivered in the usual manner. Hemorrhage is controlled by pressure, after which the rectus muscles are separated from all fascial attachments for at least 15 mm. posterior to their free ends.

The implant (fig. 5 *A*) is held by a pair of smooth forceps (*f*) above the muscle cone, with the spherical surface of the implant toward the apex of the muscle cone. The two sutures (*s*) from each muscle are passed through a tunnel from the peripheral end toward the center of the anterior surface of the implant, laid aside and secured with hemostats. After all the sutures and muscles have been passed through their respective tunnels, the medial and lateral rectus muscles are overlapped (fig. 5 *B*) in the recess formed by the opening in the center of the anterior surface of the implant. The suture through the upper edge of the medial rectus (s_1) is placed through the upper edge of the lateral rectus approximately 5 mm. posterior to the free end and tied. The suture through the lower edge of the medial rectus (s_2) is placed through the lower edge of the lateral rectus, opposite the upper one, and tied. Similarly, the sutures from the upper and lower edges of the lateral rectus (s_3, s_4) are placed through the corresponding edges of the medial rectus and tied. The free ends of these four sutures are cut, but the needle ends are retained for use eventually as tension sutures.

The superior and inferior rectus muscles are overlapped (fig. 5 *C*) and secured in the recess in the anterior surface of the implant in the same manner as the medial and lateral rectus muscles, but both ends of the sutures are cut as soon as they are tied.

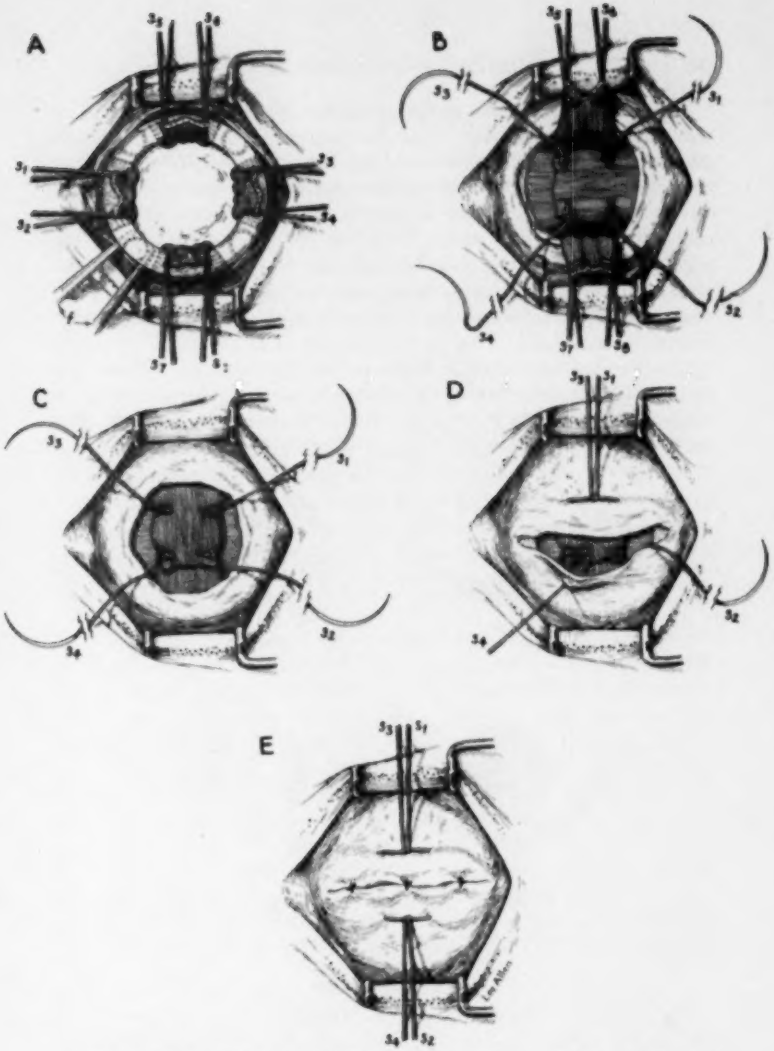

Fig. 5.—Stages in technic of placing implant in muscle cone after enucleation: In these drawings, *f* indicates forceps; *s* sutures.

A, rectus muscles pulled through their respective tunnels.

B, horizontal rectus muscles sutured in position, with needle ends of sutures retained for further use.

C, vertical rectus muscles sutured in position and sutures from horizontal rectus muscles still retained.

D, beginning of closure of conjunctiva and Tenon's capsule, showing use of sutures from horizontal rectus muscles for relief of tension.

E, tension sutures from horizontal rectus muscles in place and conjunctiva closed by interrupted sutures.

The needle ends of the sutures, from the upper border of the lateral and medial rectus muscles (s_1, s_2), are passed through Tenon's capsule and the conjunctiva above and tied (fig. 5 *D*). Similarly, the remaining ends of the sutures, from the lower edges of the lateral and medial rectus muscles (s_3, s_4), are passed through Tenon's capsule and the conjunctiva below and tied. These sutures are placed so that the edges of the conjunctiva and Tenon's capsule come together without tension. The conjunctiva is then closed in a horizontal line by three or four interrupted 0000 surgical gut sutures (fig. 5 *E*). The tension sutures then are cut.

The eye is dressed lightly, and ice compresses are used continuously for twenty-four hours after the operation, or a pressure dressing is applied for forty-eight hours. An ovoid conformer may be used after the reaction has subsided, but this is not essential.

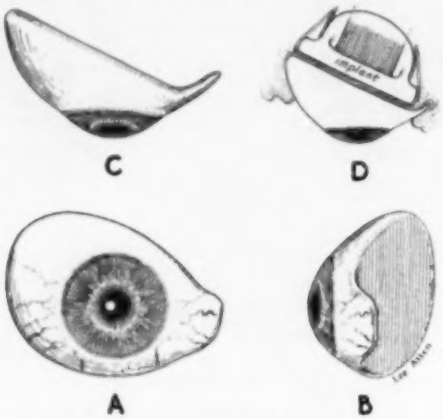

Fig. 6.—Typical plastic eye, with flat posterior surface, used with buried tunneled hemispherical implant. *A*, anterior view; *B*, view from nasal side; *C*, view from above; *D*, combined view, showing plastic eye in relation to implant, socket and caruncle.

THE PROSTHESIS

Approximately one month after the operation the prosthetic eye is fitted to the socket. Figure 6 shows four views of a typical prosthesis for a right eye. It has a flat posterior surface and a thin lip, which extends nasally to fit behind the caruncle and around the edge of the implant.

A stock prosthesis of standard irregular outline is never used without a special fitting procedure [6] because of the danger of pressure necrosis from high points on the back of the scleral segment.

6. If a stock plastic eye is used, the scleral portion should be as large as possible so that it can be shaped to fit the socket and the flat surface of the con-

There is little tendency for the plastic eye to rotate about the anteroposterior axis because the cul-de-sac usually assumes an ovoid shape after the closure of the conjunctiva in a horizontal line. In unusual cases, in which such rotation does occur, it can be corrected by reshaping the plastic eye to the exact outline of the fornices.

COMMENT

Cutler succeeded with his integrated muscle cone implant [7] where others had failed to accomplish two long desired improvements in orbital implants. He was able to position and maintain the implant properly in the muscle cone, and he made the implant transmit movement directly to the prosthesis, thus endowing the artificial eye with lifelike mobility.

It was felt that an improvement might be made over the method which Cutler had developed for retaining the implant in proper position in the muscle cone. Whereas he had looped and sutured individual rectus muscles around a wire ring on the anterior portion of the implant, it was thought that distribution of this work to larger areas of the rectus muscle tissue would reduce the danger of pressure necrosis occurring at the points of attachment. Later it was found that additional factors were involved in extrusions.

A muscle cone implant of the integrated type was designed to accomplish the desired improvement in muscle attachment. Four tunnels were arranged through the implant in such a manner that the rectus muscles could be passed through and sutured to each other on the anterior surface. The muscles thus formed a crossed, slinglike support for the implant, while the tunnels prevented the muscles from slipping from the anterior surface of the implant. The fact that the muscles had been split lengthwise and each muscle placed astride a gold peg projecting from the anterior surface before suturing was entirely incidental to the method of support. The gold peg was used only to transmit movement from the implant to the prosthesis.

The implant gave very satisfactory functional results, but in a large percentage of cases there sooner or later developed profuse purulent

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junctiva overlying the implant. If such a prosthesis is available, the fitting process consists merely of grinding the back of the plastic eye to a flat surface with slightly rounded edges, leaving a short tip extending nasally and buffing or polishing the reworked surfaces. Stock plastic eyes which are too small to be thus handled may be filled out to the proper size and shape by adding dental inlay wax to the posterior surface. When the fitting has been completed in this manner, a mold is prepared, the wax removed and plastic material added to the stock eye in the mold. This is a process which may be accomplished by the maker of the plastic eye or by a dental laboratory.

7. Cutler, N. L.: A Positive Contact Ball and Ring Implant for Use After Enucleation, Arch. Ophth. **37**:73-81 (Jan.) 1947.

discharge from the socket. In some instances conjunctivitis occurring on the side of the implant was treated and the infectious agent eliminated without residual infection around the implant. However, in most cases it was impossible to eliminate the infection and discharge with presently available therapeutic agents.

For these reasons, a new form of the implant was developed which eliminated the peg. This permitted complete closure of the tissues over the implant, thus preventing direct invasion of infectious agents into the tissues surrounding it.

When the decision was made to eliminate the peg from the tunneled implant and completely close Tenon's capsule and the conjunctiva over the anterior face, consideration had to be given to the matter of transmitting instantly as much movement as possible to the prosthesis because immediate movement, coordinated with the sound eye, is of first importance in imparting a lifelike appearance to a prosthetic eye. The greatest leverage could be applied to the prosthesis from the peripheral edges of the implant. This suggested that a large ring be placed in proper position on the implants for this purpose. However, in order that marked compression of Tenon's capsule and the conjunctiva between points on the implant and the prosthesis be prevented, broad, perfectly flat surfaces on each were thought to be ideal. Also, since neither would have a curved surface, one surface could not rotate around or within the other, as in a ball and socket joint. Therefore, the new tunneled implant was hemispherical, having a flat anterior surface except for an opening 6 mm. in diameter in the center for suturing the rectus muscles. Later, because in a large percentage of cases a dehiscence occurred in the conjunctiva over this anterior surface, it was found necessary to alter the design again in order to enlarge the opening. As already stated, this was done in order to allow the conjunctiva and Tenon's capsule covering the implant to rest on a bed of tissue, to which it might become firmly adherent.

The resultant combination of implant and prosthetic eye has rapid immediate movement (fig. 7). This movement is only slightly less satisfactory over ranges of motion up to 15 to 20 degrees from the primary position than the movement obtained with the integrated implants. Beyond a range of 15 to 20 degrees there is a noticeable lag of movement of the prosthetic eye with the buried hemispherical implant. Fortunately, however, few situations call for movement of the eyes in excess of 20 degrees. For that reason, the buried implant is very satisfactory in everyday life.

The contours of the plastic eye, eyelids and surrounding tissues are of importance to the total cosmetic appearance of the eye. The buried hemispherical implant is basically of the same shape and only slightly

less in volume than the posterior half of the enucleated eye. It cannot become displaced in the muscle cone unless there is separation of muscle tissue. The prosthetic eye is much like the anterior half of the enucleated eye. The combination then forms a satisfactory substitute both in size

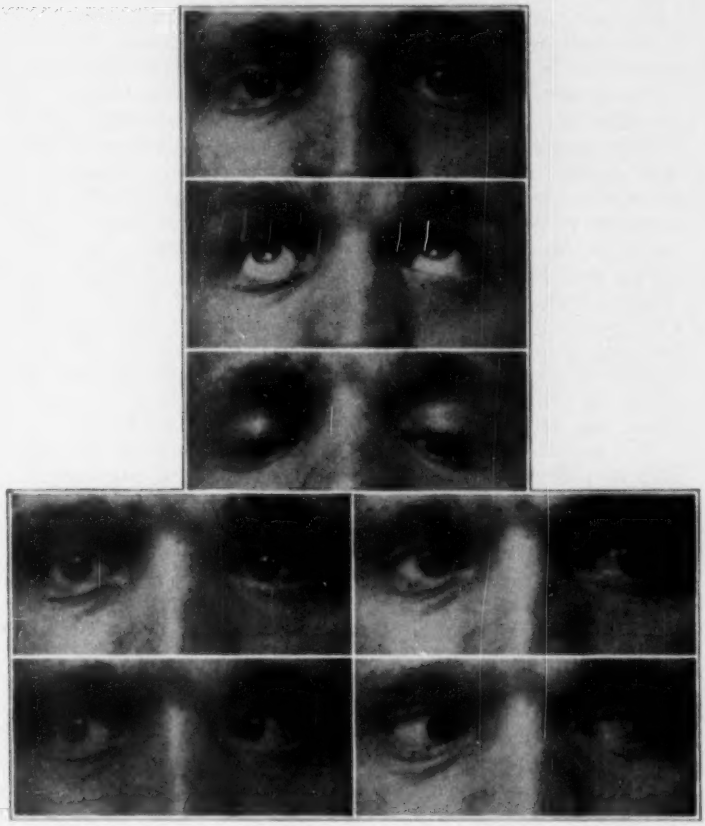

Fig. 7.—Appearance and extent of rotations in a typical buried tunneled hemispherical muscle cone implant of the latest type following an uncomplicated enucleation, with prosthesis replacing the right eye.

and in weight. Therefore these factors assure that in most cases the prosthetic eye will have a nearly normal prominence and vertical and horizontal positioning, and that the superior palpebral fold of the upper lid will present an almost normal appearance.

Whatever deepening of the superior palpebral fold does occur is no commoner with this implant than with any of the integrated implants, and much less common than with other types of implants.

Probably the most important point in the operative technic is the elimination of tension either on the rectus muscles or on Tenon's capsule and the conjunctiva. This is accomplished by careful freeing of the muscles from all fascial attachments for at least 15 mm. Then the muscles may be overlapped and sutured without fascial tissue impinging on the columns separating the tunnels and causing undue stress on the muscle tissue. This procedure also prevents the muscle from pulling Tenon's capsule into the tunnels and around from the anterior surface of the implant, thus reducing the tissue available for closure. As a further precautionary measure, the sutures from the overlapped medial and lateral rectus muscles are passed through the conjunctiva and tied so that it may be closed in a horizontal line without tension. Failure to observe these precautions may result in separation of the wound. In addition, these sutures prevent slippage of the four rectus muscles (thus preventing an unsatisfactory tilt of the implant) during connective tissue formation and keep the muscles, Tenon's capsule and the conjunctiva in close approximation, permitting firmer union of the soft tissues, and perhaps also furnishing a collateral blood supply to Tenon's capsule and the conjunctiva lying over the surface of the implant.

Postoperative reaction has been minimal with this implant, especially when the pressure dressing was applied after the surgical procedure.

Thirty-two of this late type of buried hemispherical implant have been used during the past two and one-half years, and only 1 has been lost.[8] Infection has not occurred, and sensitivity to the plastic has not developed. Several additional implants of this type have been used by ophthalmic surgeons in this vicinity, with equally good results. It is too early to arrive at a final evaluation, but the results are encouraging.

SUMMARY

The development of a hemispherical buried muscle cone implant with tunnels for the individual rectus muscles is traced, and the implant and the surgical procedure are described. This implant is completely covered by conjunctiva and Tenon's capsule. Danger of extrusion is reduced. Infectious agents cannot pass readily into the cavity occupied by the implant. The tissues in the vicinity of the muscle cone are supported in a manner which assures a satisfactory cosmetic result. Although the extent of movement imparted to the prosthetic eye with this type of implant is not so great as with the partially covered implant and integrated prosthesis, short and immediate movement is approximately as good, and therefore adequate for practical purposes.

1430 Tulane Avenue.

8. Loss is thought to have been due to failure to obtain adequate freedom from tension on the muscles and Tenon's capsule, since they separated on the fifth postoperative day.

LAMELLAR CORNEAL TRANSPLANTATION

Preliminary Report

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SYRACUSE, N. Y.

LAMELLAR, or nonpenetrating, corneal transplantation is not a new surgical procedure. This type of keratoplasty was introduced by von Hippel [1] in 1888, after a decade of discouraging experience with penetrating transplants. Using dog or rabbit cornea as donor material, he placed a full thickness graft in a window in the host cornea trephined to the depth of Descemet's membrane (posterior elastic membrane). Discussing the advantages of this operation, von Hippel stated that the lamellar operation was easier to perform than penetrating keratoplasty, that there was no danger of trauma to the inner structures of the eye or of loss of vitreous, that the graft was more easily held in position and that the graft healed more rapidly because of better nutrition. After complete healing had occurred, von Hippel observed nebulous scarring over the base of the graft, which never entirely disappeared, although usually the cornea remained clearer than the original leukoma. Prior to von Hippel's operations, von Walther,[2] Mühlbauer [2] and Dürr [3] had attempted partial thickness corneal grafts, also employing animal cornea to replace human cornea. They dissected corneal flaps, two-thirds the thickness of the cornea, in the form of equilateral triangles and placed sutures in the corners of the grafts. The majority of their transplants adhered satisfactorily but eventually became so opaque that the iris could not be seen.

After von Hippel had published his paper, a number of other ophthalmologists attempted various types of nonpenetrating corneal transplants, generally with indifferent success. In 1894 Fuchs [4] reported 30 operations performed according to von Hippel's technic, with slight

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Read in part before the New York Academy of Medicine, Section of Ophthalmology, April 18, 1949.

1. von Hippel, A.: Eine neue Methode der Hornhauttransplantation, Arch. f. Ophth. **34**:108-130, 1888.

2. Cited by Castroviejo, R.: Keratoplasty: An Historical and Experimental Study, Including a New Method, Am. J. Ophth. **15**:825-838, 1932.

3. Dürr, E.: Neue Versuche über Keratoplastik: Vorläufige Mittheilung, Klin. Monatsbl. f. Augenh. **15**:305-311, 1877.

4. Fuchs, E.: Ueber Keratoplastik, Wien. klin. Wchnschr. **7**:843-845, 1894.

improvement in vision in 2 cases. In 1908 Plange [5] performed a lamellar keratoplasty, using a corneal disk taken from the patient's other (blind) eye; the transplant was cloudy for a few weeks but then cleared so that the patient could count fingers. Five years later Plange [6] reported that the graft was still transparent. In 1910 Löhlein [7] described his method of lamellar keratoplasty. Employing parallel knives, he made two nonpenetrating vertical incisions in the cornea from limbus to limbus and dissected free the superficial layers with a conjunctival flap at each end. A similar corneal graft was then obtained from the donor eye and held in place by suturing the conjunctival flaps to the host's conjunctiva. Löhlein's grafts usually became vascularized within the first few weeks, but gradual clearing followed; he reported improvement in visual acuity to 6/60 in 1 patient. Kuznetsoff,[8] Brückner,[2] Beljaew [9] and Filatov,[10] however, reported that grafts performed according to Löhlein's technic eventually became opaque. In 1912 Morax [11] introduced lamellar corneal transplantation by transposition of portions of the same cornea; he exchanged clear grafts from the periphery of the cornea for similar disks trephined from the opacified pupillary area. In 1917 Walker,[12] reporting on 3 lamellar transplantations on patients, stated that after operation the grafts remained clearer than the original lesions. In 1921 Gradle [13] reported a nonpenetrating corneal transplantation performed according to the technics advocated by Morax [11] and Kraupa [14]; a trephine incision was made large enough to include both the opacity and a transparent peripheral area. This disk was then rotated to place the opacity toward the periphery and the transparent portion in the pupillary

5. Plange, O.: Ueber einem Fall von Hornhauttransplantation mit erhaltener Transparenz, Klin. Monatsbl. f. Augenh. **46**:277-285, 1908.

6. Plange, O.: Demonstration einer vor 5 Jahren mit Erfolg ausgeführten Hornhauttransplantation, Klin. Monatsbl. f. Augenh. **50**:490, 1912.

7. Löhlein, W.: Eine erfolgreiche Methode der Hornhauttransplantation, Arch. f. Augenh. **67**:398-426, 1910; translated, Arch. Ophth. **41**:266-285, 1912.

8. Kuznetsoff, V. A.: New Method of Transplantation of the Cornea, Vestnik. oftal. **20**:931-937, 1913; Ueber eine neue Methode der Hornhauttransplantation, Jahresb. ü. Ophth. **44**:750, 1913.

9. Beljaew: Ueber die Hornhauttransplantation, Russ. Ophth. J. 1924; abstracted, Klin. Monatsbl. f. Augenh. **74**:282, 1925.

10. Filatov, V. P.: Transplantation of the Cornea, Arch. Ophth. **13**:321-347 (March) 1935.

11. Morax, V.: Keratoplastie par transposition, Clin. Opht. **19**:108-112, 1912.

12. Walker, S., Jr.: Present Status of Corneal Transplantation and Some Experimental Data, Ophth. Rec. **26**:383-391, 1917.

13. Gradle, H. S.: The Present Status of Keratoplasty, Am. J. Ophth. **4**:895-899, 1921.

14. Kraupa, E.: Transposition durch Lappendrehung: Eine neue Methode der Keratoplastik, Centralbl. f. Prakt. Augenh. **38**:132-133, 1914.

zone. In 1926 Koppanyi and Byfield [15] described clear lamellar grafts in rabbits obtained by using mesentery as donor material.

The majority of contemporary ophthalmologists interested in corneal grafting have opposed lamellar keratoplasty. The principal argument against this operation has been the assumption that a scar would form at the base of the graft. It has also been advanced that there are too few superficial corneal lesions to warrant a nonpenetrating operation. An additional factor has been the general belief that the corneal stroma does not easily "split" into tissue planes. My interest in lamellar transplantation was aroused by observation of the ease with which the posterior layers of the cornea may be separated, or "shelved," during paracenteses, hypodermic injections, keratome incisions and ab externo knife incisions, and even by the spatula in cyclodialyses. This suggested that perhaps corneal transplants need not involve the full thickness of the

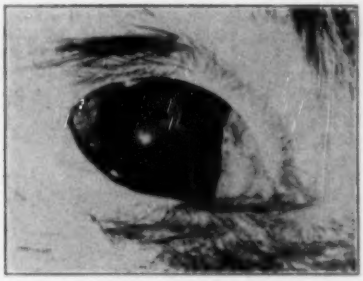


Fig. 1.—Photograph of a lamellar corneal transplant on a rabbit's eye six months after operation.

cornea. It was obvious that many of the complications of penetrating keratoplasty would be avoided if the anterior chamber were not incised. Initially, in experiments on rabbit eyes, attempts were made to carry an incision down to Descemet's membrane. Microscopic sections soon showed that, although Descemet's membrane might be approximated, this precise level was seldom reached. However, these microscopic studies revealed that the deep corneal layers could be separated in a smooth horizontal plane. Moreover, the nonpenetrating type of operation on experimental animals (rabbits and dogs) resulted in a higher percentage of clear grafts than did penetrating keratoplasty. Figure 1 is a photograph of a lamellar graft in a rabbit eye six months after transplantation. Subsequent histologic study of this eye revealed that the graft extended approximately two thirds of the depth of the cornea.

15. Koppanyi, T., and Byfield, A. H.: A Successful Corneal Transplant Using Mesentery, Am. J. Ophth. **9**:43, 1926.

No demarcation could be found between the base of the graft and the underlying host cornea, except for occasional minute centripetal extensions at the base of the circumferential scar. This circular scar was histologically similar to that seen in penetrating grafts. Microscopic sections of other lamellar grafts from rabbits killed one year, eighteen months and two years after operation disclosed a similar picture. Figure 2 shows a photograph of a lamellar graft in a rabbit eye two years after transplantation. The graft in this albino rabbit became so clear that it could not be seen against the pale iris markings, and it was necessary to dilate the pupil to demonstrate the circular scar. The results in this series of operations on experimental animals was definite evidence of the apparent feasibility of lamellar keratoplasty. Subsequently, the nonpenetrating operation was performed on patients, and the technic to be described was developed.

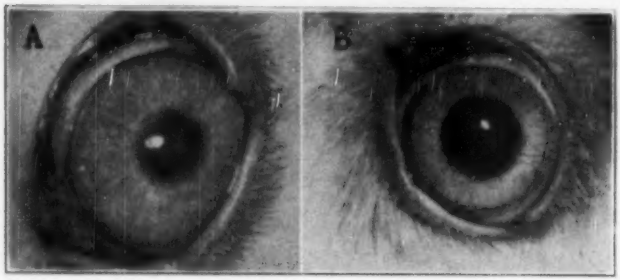


Fig. 2.—Photographs of a lamellar graft on an albino rabbit's eye two years after operation (*A*) with undilated pupil and (*B*) after dilation of the pupil.

TECHNIC OF TRANSPLANTATION

The same instruments as those previously recommended[16] for penetrating corneal transplantation are adequate for the lamellar type of operation. Likewise, the solutions and ointments employed in the former procedure are appropriate for this operation. The preoperative care and medication of the patient are unchanged. It is important to dilate the pupil as widely as possible before a lamellar operation, to provide a dark background for the surgical field. The combination of 5 per cent homatropine hydrobromide solution and 10 per cent phenylephrine (neo-synephrine®) hydrochloride solution has proved efficacious for this purpose. When the patient reaches the operating room, 4 per cent cocaine hydrochloride solution is instilled in the conjunctival sac of each eye four times, at five minute intervals.

The skin about the eye to receive the graft is prepared with 3.5 per cent iodine solution and with 70 per cent alcohol. The operative field is draped with sterile towels. A retrobulbar injection of 1.5 cc. of 2 per cent solution of procaine hydro-

16. Stansbury, F. C.: Circular Corneal Transplants: Surgical Technic; Instruments and Sutures; Comparison with the Use of Square Transplants, Arch. Ophth. **42**:155-169 (Aug.) 1949.

chloride containing 3 drops of 1:1,000 solution of epinephrine hydrochloride is given. Local anesthesia, employing 2 per cent solution of procaine hydrochloride, is then generally given by subcutaneous injection about the periorbital region. However, general anesthesia will suffice as well for the lamellar type of corneal transplantation when absolute immobility after operation is not a necessity. The conjunctival sac is flushed with 25 per cent mild silver protein U. S. P. solution and irrigated with a 1:1,000 solution of epinephrine hydrochloride. A speculum is placed between the lids. A small amount of 4 per cent cocaine solution is injected subconjunctivally in the upper and lower fornices. A bridle suture is usually placed beneath the tendon of the superior rectus muscle.

The eye is fixated with Elschnig's fixation forceps, and the portion of the cornea to be replaced is demarcated by an incision with the corneal trephine. This incision should be carried deeper than the epithelial layer. If the incision is carried down into the corneal stroma, the resulting wound will gape and fluorescein solution will not be needed to delineate the graft. Moreover, the trephine may then be removed at will, for observation of the depth of the incision, and easily replaced in the same groove. This may be done as often as appears necessary to the surgeon. When the portion to be removed is satisfactorily outlined, the corneal sutures are placed about this circle. I prefer the simple "crisscross" sutures described by Thomas [17] in 1935, and use 6-0 or 7-0, single-armed black silk corneal sutures, with atraumatic® needles. With the first suture, a bite is made into the cornea from 10 to 8 o'clock so that the buried portion of the suture is about 1 mm. from the circular incision. The same needle is then reintroduced at 2 o'clock and brought out at 4 o'clock. The two ends of this suture are placed to either side, and the loop formed from 8 to 2 o'clock is placed either above or below the circle to be excised. With the other suture, the first bite is made from 1 to 11 o'clock and the second bite from 5 to 7 o'clock. The ends of this suture are likewise extended above and below the circle, respectively, and the loop formed from 11 to 5 o'clock is placed to one side or the other of the circle to be excised. In placing these corneal sutures, care is taken to insure that the intracorneal portions (at 12, 3, 6 and 9 o'clock) are at least 1 mm. away from the circle, preferably not more than 1.5 mm. These sutures should be inserted symmetrically about the circle, so that all four segments within the corneal stroma are of the same length and so that the opposing intracorneal segments are parallel and directly opposite each other. If this is done, the sutures when tied will divide the corneal circle into eight equal parts (like the pieces of a pie). These "crisscross" sutures are easily placed out of the way during the operation and are easy to identify and tie when the graft is in place. A Moss suture may, or may not, be placed within the corneal circle to facilitate dissection of the window. Since this suture is not used in dissection of the graft from the donor eye, it is probably well to omit it entirely. The placement and final disposition of the corneal sutures are shown diagrammatically in figure 3.

When the area to be grafted is outlined and the sutures are in position, the corneal trephine is reapplied to the circular incision and carried deeper into the corneal stroma. The depth of the incision may be estimated by removing the trephine and observing the amount of gaping of the wound edges. When the incision appears deep enough to encompass the corneal lesion, the trephine is removed. The tip of an iris repositor is then introduced into the deepest portion of the incision and directed toward the center of the cornea. By to and fro movements of the repositor, a corneal plane is identified, and this cleavage plane is extended to

17. Thomas, J. W. T.: The Technique of Corneal Transplantation as Applied in a Series of Cases, Tr. Ophth. Soc. U. Kingdom **55**:373-392, 1935.

the limits of the circular incision. Extension of this cleavage beyond the incision may expose, and so weaken, part of a suture. The corneal layers are more evenly separated by blunt than by sharp dissection. When the disk is free throughout its base, it is removed from the eye. If some opacity remains within the circle after the disk has been removed, the trephine may be reapplied and the incision carried deeper into the stroma until another disk is outlined. This is separated in the same fashion and removed from the host cornea. The operator should remember that a diseased cornea may be much thicker than normal. It is no catastrophe if part of the incision is carried down into the anterior chamber; the penetrating portion of the incision will be small, and the anterior chamber will soon reform. At times, such an accident may even be helpful in that it furnishes a point of reference for determination of the depth of the incision. It is not necessary to bevel the incision, either in the host's cornea or in the donor eye. The excised corneal disk from the host's eye should be sent to the pathologic laboratory for examination.

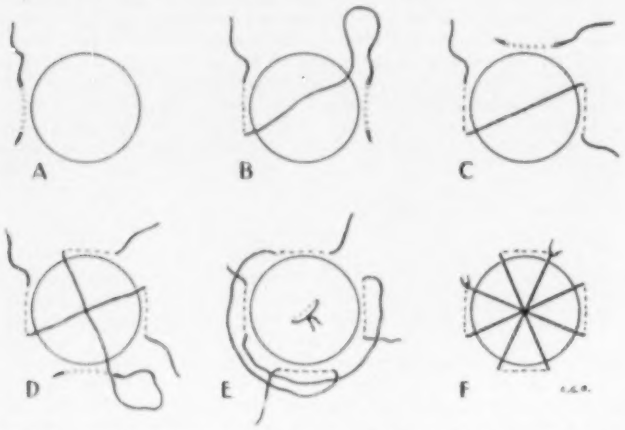


Fig. 3.—Diagram illustrating the steps in placing the "criss-cross" sutures in the cornea.

The donor eye is then held in a piece of gauze bandage, and a similar trephine incision is made. The surgeon should attempt to hold the trephine normal to the cornea, so that the incision will be equal in depth throughout its circumference. The graft is then dissected from its bed in the same manner as the leukoma was dissected from the host's cornea. The thickness of the graft should equal the depth of the window in the host's cornea. It is not advisable to prepare the graft first in a lamellar keratoplasty because there is always the possibility that a penetrating operation will be indicated. When the graft is free, it is lifted on an iris repositor and placed in the window prepared for it in the host's cornea. It is not necessary to grasp the graft at any time, either manually or with instruments.

One of the suture loops is then picked up in the curve of the small curved toothless forceps, and either end of the suture may be pulled with the straight toothless forceps until the loop lies in its proper place across the graft. The other loop is likewise lifted and drawn into position. If the horizontal suture is to be

tied first, its two ends are brought together, either at 10 or at 4 o'clock, depending on the convenience of either site, and tied without tension. In the same fashion, the vertical suture may be tied either at 1 or at 7 o'clock. Either of these sutures may be tightened first, and either may be tied first. If the sutures are pulled taut, they will indent the graft and may cause permanent scarring. The sutures serve only to hold the graft in the window in the host's cornea. The pressure of the dressing and the ensuing edema of the cornea are enough to make the graft adhere. Care should be exercised to tie the sutures close to a corneal bite, so that the knots do not lie directly over the incision. Finally, the position of the graft is adjusted with the iris repositor, the operator endeavoring to attain as good an approximation of the wound edges as possible. The speculum is removed from the conjunctival sac, and an ointment containing 1 per cent atropine sulfate is instilled. The lids are closed, and a firm Wheeler monocular bandage is applied.

The caution usually observed after a penetrating transplantation is not necessary. The patient may be allowed out of bed as soon as he desires. When he is up and about, regular diet and bathroom privileges are permitted. Codeine and acetylsalicylic acid U. S. P. are prescribed for pain. The pressure of the bandage is an important factor in holding the graft in place; therefore, careful surveillance of the dressing is in order. After four or five days, the bandage is changed. The position of the graft and sutures is checked. At this time the graft is usually swollen and cloudy, due to corneal edema. Ten per cent solution of phenylephrine hydrochloride and 5 per cent solution of homatropine hydrobromide are instilled into the conjunctival sac. A tight adhesive bandage is reapplied. Two days later the dressing is again changed. At this time the sutures are removed, 4 per cent cocaine solution being instilled topically for anesthesia. If the patient is a child or an uncooperative adult, general anesthesia may be indicated. Chloroform is a good anesthetic for this short procedure. A tight pressure bandage is again applied. If the adhesive tape does not adhere readily, the skin about the eye is painted with benzoin tincture U. S. P. and the adhesive tape "flamed" before application. Similar pressure dressings are continued for two to three weeks, depending on the amount of edema of the graft. However, a cooperative patient may be discharged from the hospital after the first week, providing adequate follow-up observation is possible. It is well to instil a mydriatic during each dressing. Refraction is usually not worth while until at least two months after operation.

REPORT OF OPERATIONS

Case 1.—The first lamellar operation was performed on the right eye of a 9 year old white girl, with a diagnosis of Salzmann's nonfamilial nodular corneal dystrophy. When the patient was 4 years of age, an attempt had been made to excise the corneal nodules, but they recurred, larger than before. Examination at the age of 8 years revealed three large, white nodules in the corneal stroma that almost coalesced into a single lesion. Superficial and deep blood vessels invaded the cornea. Visual acuity was limited to counting fingers. A superficial keratectomy was performed on the right eye in June 1947 for the purpose of improving the condition of the cornea for anticipated corneal transplantation. Objectively, this operation appeared to reduce the amount of opacification, but there was no improvement in visual acuity. In June 1948 a circular nonpenetrating corneal transplantation was performed on this eye, the graft being 6.5 mm. in diameter. The cornea was found to be much thicker than normal. Some opacification remained at the base of the incision at the end of the operation. The graft healed in position and remained clear for a few weeks. Then the surrounding opacity appeared to invade the graft, and it became opaque. Six months after operation visual acuity was

20/200 in the right eye and was not improved with lenses. The extreme photophobia, so prominent before operation, had abated. The patient's teachers reported improvement in her schoolwork. One year after operation the graft was less opaque than at six months and the patient reported that vision was improving in that eye. It was interesting at that time to note that the cornea surrounding the graft was clearing. Figure 4 shows photographs of the right eye before and one year after transplantation.

Case 2.—The second operation was performed on the left eye of a white man, aged 24 with a diagnosis of the Haab-Dimmer type of hereditary corneal dystrophy

Fig. 4.—Photographs showing the result of lamellar corneal transplantation on the right eye of a patient with Salzmann's nonfamilial type of nodular corneal dystrophy (*A*) before and (*B*) one year after operation.

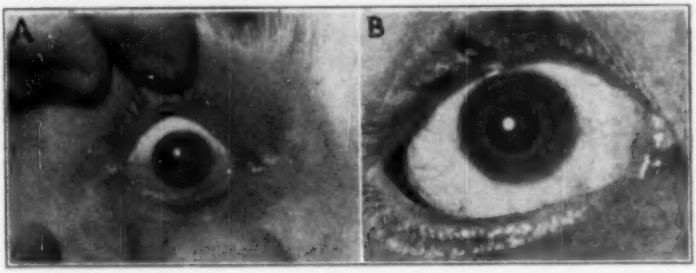


Fig. 5.—Photographs showing result of lamellar keratoplasty on the right eye of a patient with Haab-Dimmer hereditary corneal dystrophy (*A*) before and (*B*) one year after operation.

The clinical and pathologic features of the disease in this patient's family have been reported elsewhere.[18] Pathologic examination of corneal tissue obtained from other members of the family in the course of penetrating keratoplasties had revealed that the lesions were confined primarily to the anterior third of the cornea. Visual acuity was equal to perception of hand movements in the right eye and was 3/200

18. Stansbury, F. C.: Lattice Type of Hereditary Corneal Degeneration: Report of Five Cases, Including One of a Child of Two Years, Arch. Ophth. **40**:189-217 (Aug.) 1948.

in the left eye. The patient had wide exotropia, present from early childhood, with the left eye fixing. The possible advantages of lamellar corneal transplantation in "one-eyed" persons were considered. It was suggested that the operation be attempted first on the amblyopic (right) eye. Thus, in July 1948 a circular nonpenetrating transplantation was performed on this eye, the graft being 6.5 mm. in diameter. The graft adhered and remained clear. The patient reported improvement in his "side" vision. Figure 5 shows photographs of the right eye before and one year after operation.

Case 3.—The third operation was done on the right eye of a white man aged 34 who had experienced severe lime burns in both eyes four years previously. Examination of the left eye revealed absolute glaucoma. Visual acuity in the right eye was 5/200. The cornea of the right eye showed many large and small, cloudy white deposits throughout the stroma. The surface of the cornea lacked a normal curvature; there were facets, flat spots and bulges. Superficial blood vessels were present. Since the patient was blind in the left eye and the right eye appeared unfavorable for penetrating keratoplasty, the lamellar type of operation

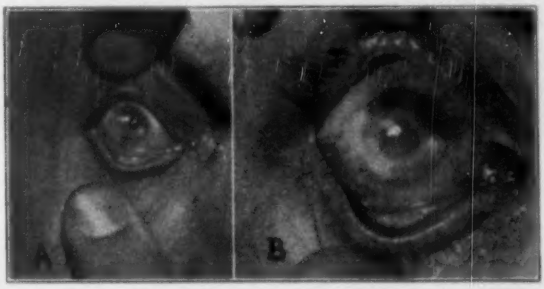


Fig. 6.—Photographs of lamellar corneal graft on the right eye of patient with severe lime burns of the cornea (*A*) before and (*B*) two months after operation.

was recommended. Therefore, in July 1948 a circular nonpenetrating transplantation was done on the right eye, the graft being 5.5 mm. in diameter. During the operation an initial disk of corneal tissue, apparently 0.5 mm. thick, was removed. Considerable opacity remained, however, and a second disk of approximately similar dimensions was dissected at the base of the first incision. Although some scarring remained in the lower third of the circular incision, dissection was discontinued because of the proximity to Descemet's membrane and because of a fairly clear area in the center of the circle. The graft healed in place and appeared clear, although opacities in the host cornea deep to the graft were still seen through the graft. Figure 6 shows photographs of the right eye before and two months after operation. Unfortunately, the patient left the country at that time and has not returned for further observation.

Case 4.—The fourth operation was done on the left eye of the patient with Haab-Dimmer hereditary corneal degeneration (case 2). The clinical and pathologic findings have been described. Preoperative visual acuity in the left eye was 3/200 and was not improved with lenses. In August 1948 a circular lamellar corneal transplantation was performed on this eye, the graft being 6.5 mm. in diameter. The graft adhered satisfactorily and remained clear. Six months after

operation, uncorrected visual acuity was 20/70 in this eye. With a + 2.50 sphere, visual acuity was improved to 20/40. Figure 7 shows photographs of the left eye before and eleven months after operation.

Case 5.—The fifth operation was performed on the left eye of a white man, aged 28 who had experienced sulfur dioxide burns of both eyes three years previously. Both eyes showed extensive corneal scarring and vascularization. Two years after the accident, superficial keratectomy was performed on the right eye, and one month later on the left eye. One year after these preliminary operations, a penetrating corneal transplantation was performed on the right eye, but the graft

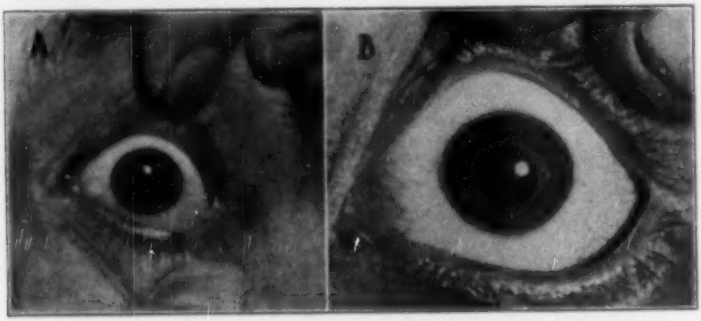


Fig. 7.—Photographs showing result of lamellar corneal transplantation on the left eye of a patient with Haab-Dimmer hereditary corneal degeneration (*A*) before and (*B*) eleven months after operation.

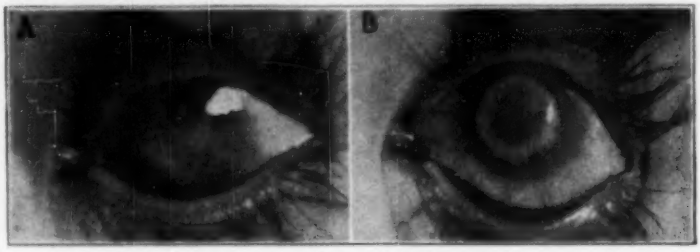


Fig. 8.—Photographs showing result of lamellar keratoplasty on the left eye of a patient with Salzmann's nonfamilial nodular corneal dystrophy (*A*) before and (*B*) six months after operation.

soon became opaque and heavily vascularized. A few months after this operation, a circular lamellar keratoplasty was performed on the left eye. This graft, likewise, soon became opaque and vascularized. No photographs are available of this eye after the operation.

Case 6.—The sixth operation was performed on the left eye of the girl with Salzmann's nonfamilial nodular corneal dystrophy (case 1). The history and clinical data have been given briefly. A superficial keratectomy, preliminary to corneal transplantation, was performed on the left eye in August 1947. Visual

acuity before and after the latter operation was limited to counting fingers. In January 1949 a circular nonpenetrating corneal transplantation was performed on the left eye, the graft being 6.5 mm. in diameter. In this operation, the incision was carried deeper into the corneal stroma than in the operation on the right eye, and, after the corneal disk had been removed, only clear corneal stroma was seen at the base of the incision. The graft adhered satisfactorily and remained clear for several weeks. Six months after operation, the opacity in the host cornea appeared to be invading the graft all about its circumference. Visual acuity was 20/200 at that time. Figure 8 shows photographs of the left eye before and six months after keratoplasty.

COMMENT

It is readily apparent that the value of lamellar keratoplasty cannot be properly appraised from the meager information contained in this report. Sufficient evidence has been accumulated, however, to indicate that nonpenetrating corneal transplantation may eventually earn a place in the regular armamentarium of the ophthalmologist. My experience with this operation on experimental animals has contributed not a little to this opinion. Although it is impossible to discuss this experimental work in detail now, it should be repeated that the results of lamellar grafts on experimental animals have been dramatically better than grafts of the penetrating type. In the series of 6 clinical operations presented in the preceding section, 2 appear to have been successful, 2 questionable and 1 unsuccessful, and the result of 1 is unknown. The second and fourth operations, on the patient with hereditary corneal degeneration, are considered successful at the time of this report, one year after operation. However, the second operation is actually only a technical success, since it was performed on an eye with amblyopia ex anopsia. These two grafts have remained continuously clear since operation; there has been no vascularization or clouding. The results of the first and sixth operations on the patient with Salzmann's nodular dystrophy are difficult to evaluate. The patient was a highly introverted young girl and difficult to examine at all times. The first operation appeared definitely to have been a failure for six months; since that time both the graft and the surrounding cornea have been clearing. The sixth operation, on the other eye of this patient, is apparently following a similar course. Clinically, the child is improved; she does not suffer from photophobia, and she is attending school regularly. An evaluation of the third operation is impossible because of the brevity of the follow-up period. The case, however, illustrates the possible advantages of lamellar keratoplasty on patients who are blind in one eye. The fifth operation, on the patient with sulfur dioxide burns of the cornea, was definitely unsuccessful. This is not surprising, considering the poor prognosis attached to lesions of this type. This series of 6 lamellar transplantations is not large enough to make the results statistically significant or to

furnish a basis for comparison with the results of penetrating transplantation. Nevertheless, one significant fact stands forth; that is the possibility of successful lamellar keratoplasty.

In spite of the fact that lamellar transplantation cannot yet be compared with the penetrating operation on the basis of results, certain advantages and disadvantages of the nonpenetrating procedure are manifest without extensive experience.

Advantages.—The outstanding advantage of lamellar keratoplasty lies in the fact that it is an extraocular operation, while the penetrating transplantation is necessarily an intraocular one. This difference alone makes the lamellar graft infinitely more conservative, in that the eye operated on is not subject to the serious complications of penetrating keratoplasty, i. e., injury to the lens, prolapse of the iris, anterior synechias and secondary glaucoma. In addition, dislocation of the graft is less likely to occur in the nonpenetrating operation. A penetrating graft is held in place solely by the corneal sutures, which exert an influence only in a direction parallel to the surface of the graft. In lamellar transplantation, however, the graft is also immobilized in an anteroposterior direction; it is held in place by the deep layers of the host cornea posteriorly and by pressure of the bandage anteriorly. Serious infection is also less likely to occur with nonpenetrating grafts. Another complication of penetrating transplantation that is not seen after the lamellar operation is the tendency for the graft to bulge some months after operation. This unfortunate occurrence is frequently severe enough to destroy any improvement in visual acuity in clear, and otherwise apparently successful, transplants.

The lamellar type of transplantation permits greater freedom in selection of the size of the graft. Few operators care to attempt penetrating grafts of more than 6 or 6.5 mm. diameter because of the increasing threat of anterior synechia and secondary glaucoma. These complications do not occur after lamellar grafts, however, and some surgeons are transplanting the anterior layers of the whole cornea. Retransplantation on an eye after a lamellar graft is more readily accomplished than a second transplantation after the penetrating operation. That the latter procedure becomes increasingly formidable with repetition is now well established. However, a second lamellar transplantation may be no more difficult than the initial one, provided that the incision in the second operation is large enough, both in circumference and in depth, to encompass the initial graft.

Lamellar keratoplasty possesses other advantages over the through and through technic, some of which are peculiar to certain patients and situations. The nonpenetrating transplantation is more feasible for children and uncooperative adults. Since the pressure bandage is relied on to hold the lamellar graft in position, a high degree of cooperation in

the patient is not necessary. For the same reason, greater choice in the selection of an anesthetic is possible for the nonpenetrating operation, and general anesthesia is as suitable as local injection. The tight bandage after lamellar keratoplasty is also responsible for shortening the patient's time in bed and length of hospitalization. After operation, absolute bed rest is not necessary for patients with lamellar grafts, and they may be allowed home after a few days, providing adequate observation is possible and convenient.

Future developments may prove that lamellar grafts are sometimes indicated for eyes with lesions extending through the entire depth of the cornea. The results of penetrating keratoplasty to date have not been good enough to abolish the reluctance of many ophthalmologists to perform the operation, particularly on patients with only one functioning eye. In such cases, lamellar grafts appear especially appropriate, regardless of the depth of the pathologic change. If this operation can be expected to lessen the opacification enough to help these patients significantly, a nonpenetrating transplantation would appear to be the procedure of choice. Finally, there is the possibility that lamellar grafts are of therapeutic value in some corneal lesions. This hypothesis of therapeutic corneal grafting was sponsored by Franceschetti [19] and is now popular in European eye clinics.

Two common complications of the penetrating corneal transplantation may occur as well after the nonpenetrating operation—opacification and vascularization of the graft. Whether these unfortunate complications follow the lamellar type of operation as frequently as the penetrating transplantation remains to be established.

Disadvantages.—The most frequently cited disadvantage of lamellar keratoplasty has been its unsuitability in eyes with through and through lesions of the cornea. However, in the foregoing discussion it was pointed out that this criticism may not be generally applicable. Admittedly, in such cases a successful penetrating graft is better than a successful nonpenetrating one, but it is questionable at present whether the incidence of successful penetrating keratoplasties is great enough to outweigh the hazards of the operation. Nevertheless, one cannot state that the results of lamellar keratoplasty are better in eyes with deep lesions; this question will not be answered until more data on the outcome of nonpenetrating grafts become available. A definite disadvantage of the lamellar keratoplasty is its obvious unsuitability to eyes with abnormalities of the corneal curvature. Thus, penetrating transplantation remains the procedure of choice in cases of keratoconus. Another disadvantage of the nonpenetrating operation, in my opinion, is its

19. Franceschetti, A.: Nouvelles indications de la greffe cornéenne, Ophthalmologica **101**:247-249, 1940.

greater technical difficulty. In the lamellar operation it is difficult to make the two trephine incisions, in the host and in the donor cornea, exactly equal in depth. It is even more difficult to dissect free the base of these incisions without considerable trauma to the corneal lamellas. Further, it is not simple to manipulate the graft, during its dissection and removal from the donor eye, without grasping it with an instrument.

CONCLUSIONS

Lamellar corneal transplantation has proved feasible in experimental animals.

Successful results with nonpenetrating corneal grafts have been attained in patients.

Lamellar keratoplasty is more conservative than penetrating corneal transplantation, in that the former operation is subject to fewer serious complications. Other advantages and disadvantages of lamellar grafts are discussed.

704 State Tower Building.

Clinical Notes

A SIMPLIFIED ASTIGMOMETER [1]

JAMES E. LEBENSOHN, M.D., Ph.D.
CHICAGO

This new astigmatic chart is durably made of vinylite plastic and hence maintains permanently its cleanliness and contrast. It is a single unit of simple design, easily handled, and requires no computation. The axes are indicated with dual numbering completely around the dial. The outer figures are read when the dial is seen in the mirror, while the inner figures, in parentheses, are noted with direct vision. The use of the dial with a mirror facilitates considerably the examination and is highly recommended. In a lightly decorated examining room the general illumination is usually adequate for the astigmatic test.

The single line cross is most suitable for the determination of cylindric power. For the location of the axis the rotating Maddox V is more efficient, since the astigmatic eye can distinguish best a difference between two lines at an angle of 60 degrees. With an inverted V placed as an arrowhead over one line, the two designs are neatly combined, and the astigmometric procedure is greatly simplified. The arrowhead is used to indicate the cylindric axis; the cross, to determine the cylindric power. The chart design thus consists simply of two long lines, making the cross, and two short lines, forming the arrowhead, all of an even 5 mm. width.

In using this dial, the eye is properly fogged and the cross lines are presented at axes 90 and 180. If the lines look alike and the wings also match, no astigmatism is present. If the clearest line is vertical, the arrow is pointed to 90 degrees; if horizontal, to 180 degrees. The attention is now directed to the arrowhead. If the wings match, the axis, as indicated by the shaft, is correct. If one wing is blacker, the arrow is rotated away from the blacker wing until matching ensues. When this occurs, the arrow shaft is at the correct axis, and no further computation is necessary. When the astigmatism is of such high degree that the wings of the arrow cannot be distinguished, the position of greatest clarity of the one line seen can still be determined. The patient will note a change in blackness and sharpness as this line is rotated in steps of 5 degrees in one or another direction.

After the axes are located, the cylindric power is next determined. The arrowhead now serves as a distinguishing mark by which the arrow line or the other can be identified. Minus cylinders are placed at right

From the Department of Ophthalmology, Northwestern University Medical School.

Read before the Section on Ophthalmology at the Ninety-Eighth Annual Session of the American Medical Association, Atlantic City, N. J., June 10, 1949.

1. The instrument described is made by Belgard, Inc., 109 North Wabash Ave., Chicago 2.

angles to the arrow line until this line, at first the clearest, is matched by the other. If the fogging is adequate, the next cylinder of 0.25 D. greater strength should reverse the contrast.

The fog is then reduced until no further visual improvement occurs, and the position of the axis is again checked by the effect of the cross cylinder on the Snellen letters. If this test indicates a divergence from the axis found with the astigmatic dial, the exact axis direction can be

The astigmometer.

decided by the Crisp-Stine test, for which the arrow line is ideally adapted.

The Crisp-Stine test can be explained best by an illustrative case. It is assumed that the provisional correction (vision 20/20) for the right eye is + 1.00 cyl., axis 15. With the letter chart the cross cylinder indicates apparently an axis of 30 degrees. The eye is fogged 0.25 D., and both the trial cylinder and the arrow line are placed at 15 degrees. The 0.12 D. cross cylinder is applied in the test for axis with the query

as to whether the wings look more alike before or after the turn of the cross cylinder. If the wings seem alike with the plus mark of the cross cylinder up, both the arrow line and the trial cylinder are moved to 25 degrees, and the test is reapplied. If, now, the wings appear matched with the plus mark of the cross cylinder down, the correct axis is 20 degrees. When both the arrow line and the trial cylinder are moved to this position, application of the cross cylinder test will show a contrast in the wings that is reversed on rotation of the instrument.

It is hoped that this simplified use of the astigmatic chart will help to extend the popularity that this technic deserves.

The chart can readily be adapted for use in the Crisp-Stine method in its original form by marking a short thin line at the midpoint of the arc subtending a clear quadrant. With the marker placed at the axis under consideration, the comparisons are then made between the arrow line and the plain line. Though the arrowhead figure carries a stronger psychologic appeal, the mathematical results slightly favor the original Crisp-Stine method. In cases with low astigmatism it is often helpful to check one method by the other.

A SOUNDPROOF CASE FOR THE CASTROVIEJO SUCTION KIT

DALE L. HAUCK, M.D.
Instructor in Ophthalmology, College of Medical Evangelists
LOS ANGELES

Many surgeons have found the Castroviejo erisiphake a fine instrument for cataract extraction, but owing to its excessive noise, it has been avoided by many operators. Both operating room personnel and patients have been unnerved by its sudden, rough note at the critical moment of a cataract extraction.

Sound proof case for the Castroviejo suction kit.

Several have tried bottle noise traps and other silencing methods, but our best endeavor has been an 8 by 14 inch (19 by 35.5 cm.) birchwood box (¾ inch [19 mm.] stock) lined with a standard acousticelotex[a] sheeting, and a floor of 2 inch (5 cm.) thick air foam,[a] on which any surgeon's motor erisiphake may be placed. Bolting down or securing is not necessary.

From the Department of Ophthalmology, College of Medical Evangelists.

The 110 volt electrical outlet is built into one end of the box, presenting a female outlet on both surfaces of the box end. The inside connects to the motor; the outside, to the foot switch. The suction hose is brought out through a groove at the top of the box, as illustrated. This groove also allows excessive positive pressure to escape.

The interior is roomy enough to allow storage of tubing, handle, tips and other instruments and furnishes enough air volume that at the end of an average thirty second run the motor is not excessively heated. The lid is secured with suitcase safety catches, and a suitcase handle turns it into a practical carrying case.

Sound readings taken at 3 foot (90 cm. distances with various methods of silencing were as follows: (1) no silencing, + 32 decibels, (2) with rubber tube muffler (standard equipment on the exhaust), + 26 decibels; (3) pump secure in box, 0 decibels.

The box absorbs all but a small amount of the noise, enough remaining that the operator can comfortably tell when the pump is working.

312 North Boyle Avenue (33).

A MODIFIED FILM CARRIER FOR THE ZEISS-NORDENSON FUNDUS CAMERA

ROBERT R. CHACE, M.D.
AND
JAMES H. LAFAYETTE
NEW YORK

Fundus photography offers an important means whereby retinal lesions can be reproduced on film for study and as a medical record. The Zeiss-Nordenson retinal camera has been the instrument most commonly used in this country. Bedell,[1] Koch [2] and others have discussed the use of this instrument in detail. The cameras were originally designed to use cassettes holding 4.5 by 6 mm. plates. These cassettes were later modified to use bantam type, 35 mm., 8 exposure roll film (either black and white or colored). When large numbers of exposures are made, the use of 8 exposure film requires frequent changes. Furthermore, the method of adapting the cassettes to hold roll film was not too secure, and there was a tendency for the film to jam, requiring that the cassette be opened in total darkness and the film removed.

To correct this, we arranged to have a new cassette constructed from an Argus camera without its optical equipment. On the figure, *A* shows the camera case, to which has been soldered the portion of the original cassette normally in contact with the rear housing of the retinal camera. It was thus possible to attach the new cassette to the camera and, at the same time, retain the movable metal plate that keeps the cassette light tight when removed from the camera. To compensate, the base of the eyepiece was elevated 30 mm. This now permits the use of 20 and 36 exposure films. There is a slight reduction in the size of the picture by 1 to 2 mm., which is of no importance (figure, *B*, *C* and *D*).

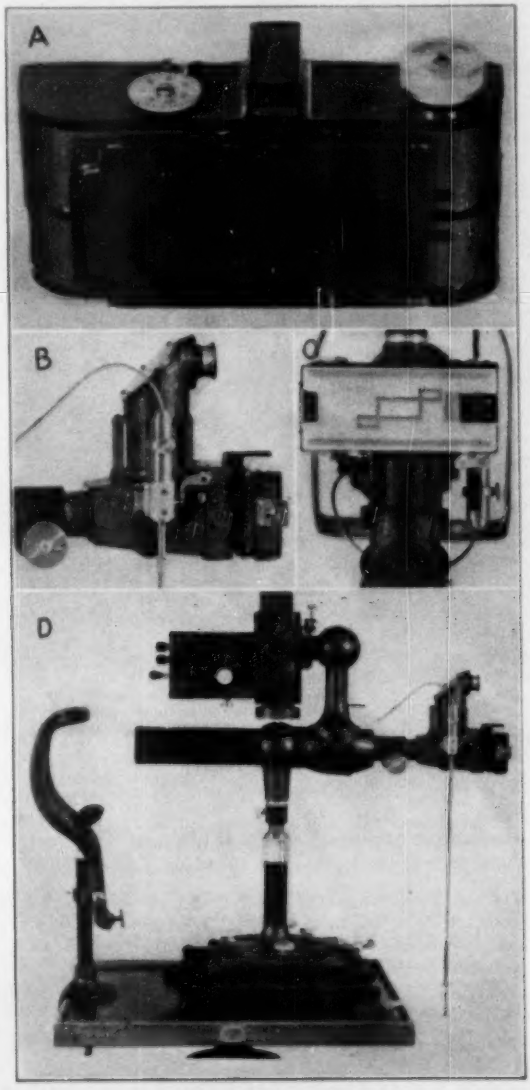
At the same time that this was done, a new cable release was installed, with its mechanism vertical rather than horizontal. This permits greater ease in making an exposure and reduces the drag on the lever moving the mirror in the rear housing.

635 West One Hundred and Sixty-Fifth Street.

From the Institute of Ophthalmology of the Presbyterian Hospital and the Department of Ophthalmology, Columbia University College of Physicians and Surgeons.

1. Bedell, A. J.: Color Photography in Ophthalmology, in Ridley, F., and Sorsby, A.: Modern Trends in Ophthalmology, London, Butterworth & Co., Ltd., 1940, p. 213.

2. Koch, F. L. P.: Color Photography of the Human Fundus: Its Technic with the Zeiss-Nordenson Retinal Camera, J. Biol. Photographic A. **9**:119, 1941; Photography of the Human Ocular Fundus, in Glasser, O., and others: Medical Physics, Chicago, The Year Book Publishers, Inc., 1944, pp. 933-937.



A, camera case; *B*, *C* and *D*, camera in place on the new cassette.

A SYSTEM OF REMOTE CONTROL APPLIED TO ASTIGMATIC DIALS

COMMANDER DAWSON A. MILLS (MC), U.S.N.

Subjective testing for astigmatism, accomplished by dials of the type made popular by Lancaster [1] and Regan,[2] is widely practiced. However, considerable effort is required in the selection of the proper axis on dial 1 and in the adjustment of dial 2 to that axis. Hence it seems appropriate to present a suitable method whereby these maneuvers may be accomplished by remote control.

Only recently, Weston [3] described a method which is in part very similar to such a procedure. However, he used only a single astigmatic

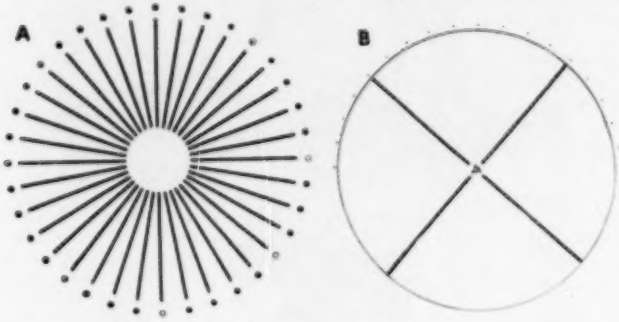


Fig. 1.—*A*, dial 1, showing several pairs of lights illuminated; *B*, dial 2 set at axis 40 or 130 degrees.

cross. Other types have been employed, utilizing principally mechanical connections.

The system to be presented consists of two large dials, each of which is constructed on a 30 inch (76 cm.) square, of thin aluminun, and the

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This article has been released for publication by the Division of Publications of the Bureau of Medicine and Surgery of the United States Navy. The opinions and views set forth in this article are those of the writer and are not to be construed as reflecting the policies of the Navy Department.

1. Lancaster, W. B.: Subjective Tests for Astigmatism, Especially Astigmatic Charts, Tr. Am. Acad. Ophth. **20**:167, 1915.

2. Regan, J. J.: Astigmatic Dials in Refined Refraction, Arch. Ophth. **17**: 788 (May) 1937.

3. Weston, H. L.: An Electrical Remote Control for the Revolving Astigmatic Cross, Am. J. Ophth. **32**:1272, 1949.

control box. Dial 1 consists of ¼ inch (6 mm.) black tapes, each 10 inches (25 cm.) long, arranged radially at 10 degree intervals within a circle of 26 inch (66 cm.) diameter (fig. 1). At the distal end of each tape is a small jeweled light, such as is used as an indicator light on television sets and radios. The lights may be illuminated in pairs (two in each meridian) by the corresponding switches, arranged in a half-circle on the control box (fig. 2). Dial 2 consists of a 26 inch movable disk on which the ¼ inch black tapes form a cross, with arms constructed at right angles. The base plate serves as a protractor and is marked in 10 degree intervals. On the shaft of dial 2 is mounted a small "selsyn" generator, which is wired to an identical unit in the control box. Thus, when the control knob (fig. 2) is rotated, dial 2 moves correspondingly. The dial may be set at any desired axis.

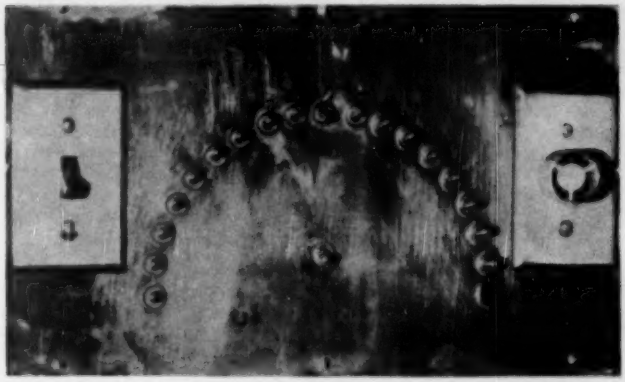

Fig. 2.—The control box. The master switch is on the left; the axis switches are in the center, and the control knob for dial 2 is on the right.

The control box may be arranged at any position convenient to the examiner. It contains, in addition to the "selsyn" unit and light switches, a standard 110 volt doorbell transformer, which operates the indicator lights, and a master switch, which controls the power to the entire system. The motors operate on 110 volt alternating current.

In operation, the patient (after retinoscopy, fogging and other suitable preliminary procedures) is asked to give a clue to the darkest line on dial 1. By using the lights, the subject indicates the proper line to the examiner, who then sets dial 2 to the corresponding position.

This entire system has been in use in the clinic of the naval hospital with which I am associated for just over one year with satisfactory results. It is simple, inexpensive and reasonably foolproof.

LID EXPRESSION FORCEPS

GERALD B. SPERO, M.D.
DETROIT

Expression of the lids is a valuable procedure in the treatment of blepharitis or blepharoconjunctivitis. Only too often does one forget to do this. If expression reveals considerable secretion, it should be done once or twice weekly for a number of weeks, until the secretion becomes minimal.

Prior to expression, a few drops of tetracaine hydrochloride U. S. P. (pontocaine®) or other local anesthetic are instilled. In cases in which the secretion is considerable, injection of staphylococcus toxide may be

Lid expression forceps.

helpful. In some instances, minimal doses of roentgen radiation may be tried. Material for smears and cultures should be taken wherever possible. Penicillin, the sulfonamide drugs, astringents and other local medicaments are frequently of value.

Recently I designed an expressor forceps. Although it has limitations, I think it is better than anything which I have used or seen. It is simple to use and takes little time. The blades adapt themselves easily to the lids.

This instrument may be obtained from V. Mueller & Co., Chicago.

News and Notes

EDITED BY DR. W. L. BENEDICT

SOCIETY NEWS

Austrian Otolaryngological Society.—The Austrian Otolaryngological Society, Vienna, will hold its annual meeting on September 18 to 20 in Bad Gastein, Austria. The leading topic will be "Professional Diseases of the Eye, Ear, Nose and Throat." Discussion will be opened by Prof. Dr. L. Ruedi, of Zurich, and Prof. Dr. W. Stopka, of Wiener Neustadt. Other topics within the field of otolaryngology will be presented.

For information, write Prof. Dr. E. Schlander, president, or Doz. Dr. O. Novotny, secretary, Vienna IX, Alserstrasse 4, Austria.

Virginia Society of Oto-Laryngology and Ophthalmology.—The Virginia Society of Oto-Laryngology and Ophthalmology will hold its annual meeting jointly with the West Virginia Academy of Ophthalmology and Otolaryngology at Hotel Greenbrier, White Sulphur Springs, W. Va., May 8 and 9, 1950.

New England Oto-Laryngological Society.—The New England Oto-Laryngological Society will hold its regular spring meeting Wednesday, June 14, 1950, at the Massachusetts Eye and Ear Infirmary.

Pennsylvania Academy of Ophthalmology and Otolaryngology.—The annual meeting of the Pennsylvania Academy of Ophthalmology and Otolaryngology will be held May 12 to 14 at the Bedford Springs Hotel, Bedford, Pa. Among the speakers who will present papers at this meeting will be Drs. Edward H. Campbell, Frank D. Costenbader, Karl M. Houser, Raymond E. Jordan, John E. L. Keyes, John A. Kolmer, Francis L. Lederer, Irving H. Leopold, Maurice Saltzman, Richard G. Scobee, Edmund B. Spaeth and Frank B. Walsh.

In addition to the formal presentations, twelve study clubs will be conducted, to run concomitantly with the scientific sessions. Topics for discussion will be "Difficulties of Refraction in Presbyopia" and "Common Office Procedures in Otorhinolaryngology."

Sixth Brazilian Jornadas of Ophthalmology.—This will be held in São Paulo, Sept. 3 to 7, 1950. These meetings are held in the years between national congresses in order to keep the ophthalmologists together. The *Jornadas* this year will be sponsored by the Centro de Estudos de Oftalmologia, and the Sociedade de Medicina e Cirurgia de São Paulo has also promised its support to the project.

Brazilian Congress of Ophthalmology.—The Seventh Brazilian Congress of Ophthalmology will convene in Quitandinha, July 9 to 15, 1951. The following official speakers and subjects have been chosen: Dr. Rubens Belfort de Mattos, Centro de Estudos de Oftalmologia: "Tissue Therapy"; Dr. Paulo Braga Magalhaes, Sociedade de Oftalmologia de São Paulo: "Semiology of the Pupil"; Dr. Luiz Assumpção Osorio, the Sociedade de Oftalmologia e Otorinolaringologia do Rio Grande do Sul: "Ametropias and Their Correction in Infancy."

PERSONAL NEWS

Dr. Ronald Atmore Cox Appointed Professor of Ophthalmology, George Washington University School of Medicine.—Appointment of Dr. Ronald Atmore Cox as professor of ophthalmology and executive officer of the department of ophthalmology of the George Washington University School of Medicine has been announced by Dr. Walter A. Bloedorn, dean. Dr. Cox also has become chief of the department of ophthalmology at the George Washington University Hospital. He replaces in all these positions Dr. Ernest A. W. Sheppard, who has resigned to devote more time to research. Dr. Sheppard will continue to teach at the university's School of Medicine.

Dr. Cox was appointed to the University in 1935 and has been an assistant clinical professor of ophthalmology and associate university physician. He plans to represent the university at the Sixteenth International Congress of Ophthalmology, which meets in London in July, when he will deliver an address on ocular brucellosis.

He is a Fellow of the American Medical Association and a fellow of the American Academy of Ophthalmology and Otolaryngology and of the American College of Surgeons. He is a certified specialist of the American Board of Ophthalmology, a member of the Pan-American Association of Ophthalmology and a member of the Wills Hospital Society of Philadelphia.

Dr. Samuel I. Kaufman Appointed to Faculty of Chicago Medical School.—Dr. Samuel I. Kaufman has been appointed to the faculty of the Chicago Medical School as assistant professor of ophthalmology, it is announced by Dr. John J. Sheinin, dean.

Dr. Kaufman received his medical degree from Loyola University School of Medicine. Postgraduate studies were taken at the University of Illinois, the University of Munich and the University of Vienna. He is a certified specialist of the American Board of Ophthalmology and is presently on the staff of Mount Sinai Hospital.

GENERAL NEWS

Professional Illustrators and Photographers.—The Academy-International of Medicine is establishing an information service on professionally trained medical illustrators and photographers who will assist members of the medical profession in the preparation of all types of papers for publication and meetings, visual demonstrations and exhibit material. Information on illustrators and photographers is to be available, on request, to all members of the medical profession.

All physicians having personal knowledge of competent illustrators or photographers are requested to assist by providing the technicians' names and addresses. Send information to Academy-International of Medicine, 214 West Sixth Street, Topeka, Kan.

Course on Oculorotary Muscles, Washington University School of Medicine.—The Department of Ophthalmology of Washington University School of Medicine will present its annual short, intensive course on the oculorotary muscles from June 12 through June 24, 1950. The course will be limited to nine students and will include twenty-eight hours of didactic instruction, twenty-seven hours of clinical instruction and ten hours of surgical demonstration. The instructors will be Dr. Richard G. Scobee, Dr. George T. Stine and Dr. David M. Freeman. Tuition will be $150, and only those at least eligible for the American Board of Ophthalmology will be accepted. Inquiries about the course should be addressed to Dr. Richard G. Scobee, 640 South Kingshighway Boulevard, St. Louis 10.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

NERVOUS INFLUENCES UPON THE OCULAR MUSCLES. MARTIN BARTELS, Arch. f. Ophth. **148:** 107 (Sept.) 1947.

A new and complicated diagram is presented to illustrate the manifold pathways leading to the centers and nuclei which control ocular movements.

P. C. KRONFELD.

THE ELASTIC TISSUE IN THE VESSELS OF THE EYE. H. MEVES, Arch. f. Ophth. **149:** 275 (April) 1949.

In previous papers the author has described a typical difference in the arrangement of the elastic fibers in the retinal and the choroidal arteries. One well defined internal elastic layer is present in the choroidal arteries, whereas in the retinal arterioles the elastic elements form a scaffolding between and around the muscle cells of the vessel wall. The latter diffuse arrangement prevails to some extent in the greater arterial circle of the iris. The arteries in retinal and in choroidal tumors show the type of elastic tissue arrangement characteristic of their mother tissue.

P. C. KRONFELD.

THE LYMPHATIC VESSELS OF THE HUMAN CONJUNCTIVA STUDIED BY MEANS OF INJECTION OF TRYPAN BLUE. A. BUSACCA, Arch. d'opht. **8:** 10, 1948.

The biomicroscopic examination of patients with leprosy of the eye treated by local injections of trypan blue suggested to the author some years ago the idea of applying this method to the study of the normal and the pathologic human conjunctiva. This extensive article is accompanied with many black and white drawings and a number of colored plates, with an accompanying description of each case studied. As the result of these studies and the review of the literature on the subject, the author states the opinion that a modification in present day views will need to be made. Whether or not there is a definite connection between the lymphatics of the limbus and the corneal spaces, as suggested by Waldeyer, is left open. The method used by Busacca does not help in the solution of this question. This method reveals the presence of a lymphatic network about the limbus composed of two parts, one situated in the terminal zone and the other in the pallisadal zone. These two portions of the network have characteristic differences, and these differences are described. The lymphatic vessels of the conjunctiva are situated in practically the same plane as the superficial conjunctival vessels, but for the most part a little behind them. In their general picture the vessels in the pallisadal zone correspond to the radial vessels described by Teichmann. As the result of this study, Busacca believes that there is no lymphatic sheath around the conjunctival blood

vessels, as has been maintained by others, and that there are no lymph follicles along the course of the normal conjunctival lymphatics. His studies lead him to believe that there is no episcleral lymphatic network which can be injected by this method. The article gives a careful review of the work which has been done up to the present time.

S. B. Marlow.

Aqueous Humor

Influence of Gum Arabic [Acacia] and Dextran on the Blood-Aqueous Barrier and Intra-Ocular Pressure. E. H. Bárány, Ophthalmologica **116:** 65 (Aug.) 1948.

Experiments of Dieter and Duke-Elder showed a decided fall in intraocular pressure in rabbits after intravenous injections of hypertonic solution of acacia U. S. P. (gum arabic). The pressure fell shortly after the injection and remained below normal for fifty hours. The intraocular hypotension was believed to be due to the increased colloid osmotic pressure of the blood. In repeating these experiments, Bárány found similar curves and noted the appearance of a considerable amount of colloid in the anterior chamber. The experiments were continued with a 4 per cent solution of acacia, which has a lower colloid osmotic pressure than rabbit plasma, and identical results were obtained. Since acacia is not a chemically pure substance, native dextran and dextran hydrolysate were used for further studies. Since the hydrolysate has a much higher colloid osmotic pressure in the blood than has native dextran, the hypotony of the eye should be more pronounced if it were a result of colloid osmotic changes in the blood. It was found, however, that neither concentrated nor dilute solutions of dextran hydrolysate produced any notable changes in intraocular pressure. The results obtained suggest that acacia and native dextran have some kind of toxic action which influences the blood-aqueous barrier. This belief is substantiated by the highly increased sedimentation rate of the red blood cells and the appearance of colloid in the aqueous. The toxic effect might be due to micro-emboli of erythrocytes, as observed by others in the liver and kidney after the injection of high polymeric plasma substitutes. The hypotony of the eyeball is explained by the leakage of electrolytes from the aqueous into the blood through the damaged barrier. The use of the slit lamp is suggested for testing the properties of plasma substitutes.

H. P. Kirber.

Color Sense

Color Blindness After Head Injury. Herbert Schober, Arch. f. Ophth. **148:** 93 (Sept.) 1947.

A case of color deficiency following head injury is described in detail. It is reasonably certain that the patient possessed normal color sense up to the time of injury which consisted of a rifle shot grazing the occipital region. Fragments of a bullet were found in the muscle and periosteum. The skull had not been perforated. During the recovery the patient complained of hemianopsia and dizziness. The latter persisted up to the time of examination by the author (fifteen months after the injury). The principal findings were cerebellar ataxia,

tetranopic paracentral scotomas for white and colors, otherwise normal fields for blue and yellow, but complete loss of the fields for red and green. Thorough investigation of this color deficiency revealed characteristics of protanopia as well as of deuteranopia. The author stresses this finding which his case had in common with the few previously reported cases of color deficiency due to cortical lesions. Protanopia, deuteranopia and tritanopia are the typical representatives of the congenital, retinal forms of color deficiency. Acquired cortical color deficiency does not fit into any of these groups. It is the result of a very superficial injury to most of the visual cortex.

P. C. KRONFELD.

COLOR THRESHOLDS OF THE CENTRAL AREA. P. CIBIS and H. HUCK, Arch. f. Ophth. **149:** 176 (April) 1949.

The color perception of the central area (of the retina) was tested monocularly by determining (1) the greatest distance at which the color of rectangular pieces of Engelking-Eckstein color papers could be recognized, and (2) the fading or disappearance time of the color of such targets under conditions of maintained fixation. Both measurements were made on a representative number of subjects with normal color sense, as well as on persons with anomalous trichromasy, including persons with the yellow-blue anomaly. In contradistinction to the Rayleigh equation, which expresses the red-green relationship, the determinations reported in this paper are concerned with the perception of the individual colors and are, therefore of theoretic, as well as of diagnostic, value.

P. C. KRONFELD.

Congenital Anomalies

OPERATION FOR PERSISTENT PUPILLARY MEMBRANE: REPORT OF A CASE. Z. BÁTHORI, Brit. J. Ophth. **32:** 505 (Aug.) 1948.

A woman aged 30 had always had poor vision. Corrected vision equaled 5/50 in the right eye and 5/12 in the left eye. In the right eye the pupillary area was occupied by a mass of brownish tissue, identical in color with the iris and slightly prominent. The slit lamp beam showed a dense central part 1.5 mm. in diameter, from which originated a mesh of threads of varying thickness, passing radially toward the crypts of the iris. The pupillary margin could be seen through the mesh, and the pupil was active. The lens appeared clear. The left eye showed a similar, but less distinct picture. Here, the central dense mass was only 0.5 mm. in diameter. The lens, media and fundus showed no abnormal changes. The right eye was operated on by Imre. After an incision with the keratome, the filaments were pulled into the wound, one by one, with a small iris hook and severed with de Wecker scissors, and eventually the whole pupillary membrane was removed. After operation, the entire area of the pupil was clear, and vision had improved to 5/8.

W. ZENTMAYER.

OCULAR CHANGES IN ARHINENCEPHALY. G. BEDTKE, Arch. f. Ophth. **148:** 490 (July) 1948.

The author has made a detailed study of a microphthalmic, arhinencephalic monster. Gross examination revealed aplasia of the optic nerve

and of the nerve fiber layer within the retina, aplasia of the macula and fovea, folding of and rosette formation in the outer retinal layers, aniridia, atypical coloboma of the iris and ciliary body above, hypoplasia of the ciliary body and persistence of the embryonic vascular system. The hypoplasia of the ciliary body was found to be closely related to the development of the nonpigmented ciliary epithelium.

P. C. KRONFELD.

CONGENITAL MEGALOCORNEA. R. FRIEDE, Arch. f. Ophth. **148:** 761 (Dec.) 1948.

A family with 4 cases of megalocornea is reported. In 2 of the cases the author performed cataract extractions. After weighing carefully the various existing theories of the origin of megalocornea, he restates his own view (reported before) that megalocornea is a phylogenetic developmental anomaly.

P. C. KRONFELD.

EMBRYOTOXON CORNEAE POSTERIUS AXENFELD. H. HUGGER, Arch. f. Ophth. **148:** 780 (Dec.) 1948.

The author describes 2 cases of a distinct white line, parallel with the limbus, in the deepest and very peripheral portions of the corneas. One eye showed other anomalies and an increased ocular tension. From the appearance of the eyes in his cases and the study of the literature, the author interprets the disturbance as due to a displaced canal of Schlemm. He apparently did not examine his patients gonioscopically, nor does he seem aware of the gonioscopic study of this condition by Busacca and Pinticart (*Ophthalmologica* **115:** 283 [May] 1948).

P. C. KRONFELD.

Conjunctiva

PROPHYLAXIS OF OPHTHALMIA NEONATORUM WITH PENICILLIN. P. HALBRÓN, F. LEPAGE, C. LECOMTE and H. MAWAS, Ann. d'ocul. **181:** 676 (Nov.) 1948.

The authors review the treatment of ophthalmia neonatorum and cite the striking reduction in the incidence of this disease with the introduction of the use of silver nitrate. The disadvantages of silver nitrate is mentioned, especially its irritating effect on the conjunctiva. The efficacy of penicillin being well established, this substance was tried in 2,000 cases. Two drops of a penicillin solution containing 5,000 units per cubic centimeter was instilled in both eyes after birth. In their series there occurred 1 case of gonococcic conjunctivitis which responded promptly to penicillin therapy.

The authors conclude that penicillin is a safe prophylactic agent against ophthalmia neonatorum and that it is less irritating than silver nitrate.

P. R. MCDONALD.

PRIMARY COMPLEX OF THE CONJUNCTIVA. RUBENS BELFORT MATTOS, Arq. brasil. de oftal. **11: 7,** 1948.

A girl aged 4 years had had a hordeolum in the right eye for five months. The right palpebral fissure was of normal size, but was

slightly irregular in the upper internal portion. The upper lid showed loss of substance of about 1 mm. in the internal third to the roots of the eyelashes, with various infected glands. On the upper lid, at the internal third, was observed a perfectly outlined formation, measuring 1 by 1.5 cm., of irregular form with tissue proliferation in the form of follicles, some of which were ulcerated. A week later, after the use of sulfanilamide, material for biopsy was obtained. In the center of a section of skin there was an inflammatory nodule, the central portion of which was necrosed. Surrounding it was histiocytic reaction with Langhans giant cells. Surrounding this was lymphocytic infiltration. A diagnosis of active tuberculosis was made. General tonics and preparations of vitamins A and D and mineral salts were prescribed.

M. E. Alvaro.

Cornea and Sclera

The Epidemiology of Epidemic Keratoconjunctivitis. P. Thygeson, Am. J. Ophth. **32**: 951 (July) 1949.

Thygeson states that the high communicability of epidemic keratoconjunctivitis appears to be due to the ability of the virus to survive drying and dilution. In this respect it differs from other potentially epidemic types of keratoconjunctivitis, such as gonorrheal ophthalmia and trachoma.

In the present study, transmission of the disease has been shown to have occurred by the following means: (*a*) contaminated tonometers, (*b*) contaminated solutions, including those of tetracaine, cocaine-epinephrine and homatropine, (*c*) direct finger to eye transmission and (*d*) industrial equipment, especially welder's masks, goggles and common tools.

In view of the high frequency of office transmissions, routine office practice should be reexamined. The following prophylactic measures are to be recommended: (1) discarding of all dropper bottles, (2) use of individual sterilizable droppers, (3) adequate hand washing before and after treatments, (4) use of disposable arm covers for the treatment chair and (5) individual masks and goggles for workers in industry, with early recognition and isolation of cases.

W. S. Reese.

Interstitial Keratitis and Penicillin. J. Voisin, Bull. Soc. d'opht. de Paris **1**:47 (Feb.) 1948.

A case is reported in which interstitial keratitis had existed in one eye for some time and had originated in the other eye at the time penicillin was given, both locally, by subconjunctival injection, and systemically by intramuscular injection. Impressive was the fact that subconjunctival injection in the acutely inflamed eye apparently was most efficacious. The question is raised whether the penicillin acts as a bacteriostatic or as an antiallergic agent.

L. L. Mayer.

Superficial Filamentous Keratitis Associated with Deep Griddle Keratitis. G. Leoz de la Fuente, Arch. Soc. oftal. hispano-am. **7**: 533 (June) 1947.

Filamentous keratitis is a rare condition. Sourdile, in a special study of the disease, found an incidence of 5 in every 10,000 patients examined.

Not less rare is the Haab-Dimmer griddle type of keratitis. The association of the two conditions in a case and their simultaneous appearance and disappearance is the subject of the author's communication.

The patient, a man aged 54, with no history of previous disease, complained of the sensation of a foreign body in the left eye with photophobia and lacrimation for six days, followed by severe pain radiating to the periorbital region and chemosis of the conjunctiva. Examination of the stained cornea with the slit lamp revealed the presence of filamentous and griddle type keratitis.

The author discusses fully the etiology of these two forms of keratitis. In his case the origin proved to be infectious, as shown by the results of treatment, which produced disappearance of the lesions in eleven days. After using the routine treatment for corneal lesions (heat, ethyl morphine hydrochloride, yellow mercuric oxide), without favorable effects, he instilled in the eye a solution of sulfathiazole four or five times a day. This produced rapid improvement and complete disappearance of the condition.

H. F. Carrasquillo.

A New Type of Corneal Dystrophy (Dystrophia Filiformis Profunda Corneae). G. Maeder and P. Danis, Ophthalmologica 114: 245 (Oct.-Nov.) 1947.

Fine filiform opacities situated in the deepest corneal layers in front of Descemet's membrane, all in the same level, with a clear margin 2 mm. in width at the limbus, were seen in the eyes of a healthy woman aged 40. They were of slight corkscrew appearance and appeared white in direct illumination and bluish in retroillumination. The condition was associated with keratoconus. In the discussion of the case, Amsler pointed out that the condition probably bears no relation to keratoconus, since he had never seen it in his series of 270 cases of the latter. The article is well illustrated.

H. P. Kirber.

Therapeutic Corneal Transplantation in Purulent Keratitis. Langer, Oftal. J. 3: 34, 1946.

Langer reports on 12 eyes with severe purulent keratitis for which the usual methods of treatment were of no avail; vision was equal only to light perception, and the ulcer occupied from one to two thirds of the cornea. As a last resort, he performed corneal transplantations on these "doomed" eyes. A corneal disk removed from the ulcer with a trephine was replaced with a corneal transplant, which was fixed either with crossed sutures or with a conjunctival flap. In 4 cases vision was improved to from 0.1 to 0.3; in 6 cases, finger counting and light perception were preserved. Only 2 eyes were lost, the patients being senile, debilitated men. The operation resulted in cessation of pain and aided in the absorption of the purulent infiltration. In nearly all cases the presence of anterior synechia required a prophylactic iridectomy (to prevent glaucoma). The favorable result of keratoplasty in these eyes is due to the stimulating action of the transplant on the corneal tissue of the host and to the increase in its regenerative power.

O. Sitchevska.

Experimental Pathology

REGENERATION OF NERVES IN EXPERIMENTAL CORNEAL GRAFTS IN RABBITS. W. KORNBLUETH, A. E. MAUMENEE and J. E. CROWELL, Am. J. Ophth. **32**: 651 (May) 1949.

Kornblueth, Maumenee and Crowell tested the return of corneal sensitivity in 12 clear and 10 cloudy transplants. The ingrowth of corneal nerves was studied histologically by use of the silver impregnation technic in 17 clear and 13 cloudy grafts. The return of deep sensibility in the grafts in four to six weeks corresponded to the growth of nerves into the midstroma. The acquisition of light sensibility in three to four months corresponded to the penetration of nerves into the subepithelial and epithelial regions of the grafts. No appreciable difference was found in the regeneration of nerves into clear or cloudy grafts. The ingrowth of nerve fibers was not dependent on the invasion of the grafts by blood vessels.

W. S. REESE.

General

SELF-STERILIZING OPHTHALMIC SOLUTIONS. S. D. MCPHERSON JR. and R. M. WOOD, Am. J. Ophth. **32**: 675 (May) 1949.

From their experiments, McPherson Jr. and Wood suggest the use of benzalkonium to sterilize ophthalmic solutions except those with nitrate, salicylate or fluoresceinate radicals. Such solutions with phosphate buffers were found sterile two and four weeks after being placed in use.

W. S. REESE.

PREVENTION OF INFECTION IN EYE SURGERY. M. H. POST JR., Am. J. Ophth. **32**: 679 (May) 1949.

Post recommends chemical solutions to sterilize instruments, particularly solution 4, which contains cresol, lavender oil, thymol and 95 per cent ethyl alcohol. He also suggests the use of desiccators in the instrument cabinet.

W. S. REESE.

ENDOGENOUS OCULAR INFLAMMATIONS: AGE AND SEX FACTORS. O. MARCHESANI, Arch. f. Ophth. **149**: 69 (April) 1949.

The author has continued his studies of endogenous inflammations in the light of the concept (developed in previous publications) that only a small portion of all endogenous ocular inflammations are due to the direct effects of bacterial metastases or to a state of toxemia. In most cases a whole chain of factors causes the endogenous inflammation and determines its individual variations. No sharp line can be drawn between etiology and pathogenesis. Alterations in the vegetative nervous system represent an essential causal (or pathogenic) factor by modifying the innervation of the vascular bed in the diseased eye. The paper under review contains data concerning the age and sex incidence of phlyctenular disease, endogenous uveitis and retinal periphlebitis. Statistical determination of the age and sex factors in these diseases permits the distinction, within certain limits, between the effects of ectogenous and those of endogenous (constitutional) influences. Phlyctenular disease shows the well known age factor but no sex factor. This age factor expresses the age dependence of the exudative-lymphatic diathesis which

is the basis of phlyctenular disease. The abnormal diathesis is a phenomenon of an abnormal state of balance within the endocrine system and the hypothalamic centers. The lymphatic hyperplasia in the upper respiratory tract irritates the adjacent vegetative nerves which control the vascular bed of the cornea and conjunctiva. This explanation is the author's concept of the pathogenesis of phlyctenular disease.

Studies of the age and sex incidence of chronic endogenous uveitis confirm the well known clinical observation of the high frequency of this disease in women at and after the time of menopause. Acute iridocyclitis is more frequent in men than in women, without any definite dependence on the affected person's age. Retinal periphlebitis is characterized by a strong age and sex factor, for which the author offers a highly speculative explanation.

P. C. KRONFELD.

General Diseases

BLINDNESS ASSOCIATED WITH HEMORRHAGE. S. LOCKET, Brit. J. Ophth. **33:** 543 (Sept.) 1949.

Locket reports 3 cases of blindness with distant hemorrhage. The first case was that of a man aged 58. The loss of vision occurred on the sixth day after hematemesis. Vision was partially lost in the right eye. Both eyes showed swelling and pallor of the disk with congestion of the veins. In the right eye there were tiny linear peripapillary hemorrhages. Four years later vision in the right eye was equal to light perception; that of the left remained normal. The second case was that of a man aged 71. Vision failed in both eyes after severe hemorrhages from the bladder. There was pallor of the optic nerve and retina. Sight was partially recovered. Before the hemorrhagic cystitis there had been a history of prolonged disability from fractures, paraplegia and carcinoma of the prostate with metastases to the spinal cord and elsewhere. The third case was that of a woman aged 25. The loss of vision occurred during profuse bleeding following an abortion. The patient was apparently blind for thirty minutes.

The early literature is surveyed, and the cases in the literature from 1924 to 1947 are reviewed.

W. ZENTMAYER.

DIABETES AND THE FUNDUS OCULI. J. M. VILA ORTIZ; C. M. SOTO; J. J. STAFFIERI and J. DE ROSA, Arch. Soc. oftal. hispano-am. **9:** 245 (March) 1949.

The authors, two ophthalmologists, an internist and a clinical laboratory man, studied 50 diabetic patients with retinopathy, in an attempt to clarify the etiopathogenic hypotheses for the retinal changes. The work was done under the following headings: (1) arterial hypertension and renal function in diabetic patients with ophthalmoscopic complications; (2) relation of the protein content of the blood to changes in the fundus; (3) alterations in the normal hemostatic mechanisms, with special reference to vascular fragility and the retinal complications in diabetes; (4) hypercholesteremia and retinal complications in diabetes; (5) hypercalcemia and its relation to diabetic retinopathy.

The authors arrived at the following conclusions: 1. No direct relation could be established between the arterial hypertension and the renal function, either separately or in connection with the severity of the diabetic retinopathy. 2. In all diabetic patients with a normal fundus the renal function was also normal. Twenty-two per cent of the patients

had vascular hypertension. 3. Twenty-six per cent of the patients had hypoproteinemia. There was no relation between the changes in the fundus and the degree of hypoproteinemia. Not infrequently patients with a normal fundus show a normal protein content. 4. There was no alteration in the bleeding and clotting time or in the petechial index in any of the cases studied. There was also no change in the calcium content of the blood. Therefore, there was no permanent disturbance in the hemostatic mechanisms. 5. Of the 50 patients studied, only 1 showed hypercholesteremia, and there was no relation between the amount of cholesterol in the blood and the intensity of the retinal lesions. Tables giving in detail the data on each patient are presented.

H. F. Carrasquillo.

Glaucoma

Ciloanolysis and Cilocycloanolysis. E. Schreck, Arch. f. Ophth. **149:** 95 (April) 1949.

The author's term "ciloanolysis" signifies electrolytic obliteration of one long posterior ciliary artery. The term "cilocycloanolysis" implies an electrolytic cyclodialysis in addition to the electrolytic obliteration of a long posterior ciliary artery. In the former procedure, one of the long posterior ciliary arteries is treated immediately behind the ora serrata in the latter procedure, just in front of the ora serrata. In both operations, an instrument resembling a cyclodialysis spatula is used to apply the galvanic current to the artery and surrounding tissues. If a cyclodialysis is combined with a ciloanolysis, a current of 0.5 milliampere is maintained throughout the entire sweep of the spatula. The author reports a number of encouraging results in human glaucomatous eyes.

No mention is made of any gonioscopic studies to determine whether this electrolytic cyclodialysis produces a permanent supraciliary cleft. The author apparently is not familiar with the paper by Du Pont Gerry. (Angiodiathermy of the Long Posterior Ciliary Arteries and Its Use in the Treatment of Glaucoma, *Am. J. Ophth.* **27:** 1376, 1944).

P. C. Kronfeld.

Injuries

Intraocular Foreign Body. E. Gron, Klin. Oczna **18:** 108, 1948.

A case is described in which a piece of wire (from a field telephone cable) 2 cm. long, reaching into the vitreous, was removed within the first twenty-four hours after the accident by grasping its end embedded in the cornea. There was hypopyon, and only a red fundus reflex was visible. Four subconjunctival injections of penicillin of 1,000 units each and three intramuscular injections of milk were given. The patient left the hospital after twelve days with vision of 5/9.

S. Schulsinger.

Lens

Statistical Data of My Cataract Operations Performed with a New Suture of the Sclera. F. Papolczy, Brit. J. Ophth. **33:**296 (May) 1949.

A 000000 black nylon suture is inserted 1 mm. from the limbus and passed parallel to it through the conjunctiva into the superficial

layers of the sclera. The cataract incision is then made with a Graefe knife. When the corneal portion of the incision has been made and the knife, still under the conjunctiva, has reached the level of the suture, the knife is withdrawn. A semicircular conjunctival flap is made above with scissors and detached from the sclera to the thread and turned back on the cornea. After both threads have been drawn out through the conjunctival tissue with anatomic scissors, a loop is formed and cut through the shreds of tissue around the wound with scissors. After the lens has been removed, the conjunctival flap is replaced and smoothed and the thread knotted three times. The entire technic of the operation as performed by the author is described.

W. ZENTMAYER.

CATARACT AFTER TREPHINING AND IRIDENCLEISIS. H. FANTA, Arch. f. Ophth. **148:** 643 (Dec.) 1948.

The relation of antiglaucoma operations to the development of progressive cataract was studied on a series of 351 glaucomatous eyes. On 216 eyes Elliot's trephining operation had been performed; on the remaining 135 eyes the operation had consisted of an iris inclusion without sclerectomy. The incidence of clear lenses after the latter operation was 87.4 per cent, and that after trephining, only 40 per cent. The cataract develops after an indefinite time and is rarely the result of postoperative hypotony. The author believes that the most important cataract-producing factor is the postoperative iritis.

P. C. KRONFELD.

INFLUENCE OF VITAMIN C AND VITAMIN K ON THE FREQUENCY OF HEMORRHAGES AFTER CATARACT EXTRACTION. N. SANSHKINA, Vestnik oftal. **27:** 30, 1948.

The antihemorrhagic action of ascorbic acid and vitamin K after cataract extraction was observed in 125 patients; 101 patients served as controls (1946). Fifteen milligrams of a vitamin K preparation and 150 to 250 mg. of ascorbic acid were given two days before and for five to seven days after the operation. In 30 patients a simple extraction, and in 85 patients a combined extraction, was done. Hemorrhage into the anterior chamber occurred in 31 patients, or 26.9 per cent. In the control group, simple extraction was done in 48 patients and combined extraction in 53 patients. Hemorrhage into the anterior chamber was observed in 18 patients, or 17.8 per cent. This apparent smaller incidence of hyphema in the control group was due to the fact that traumatic cataract prevailed in this, the younger group. Thus, the frequency of hemorrhages into the anterior chamber was little influenced by the use of ascorbic acid and vitamin K.

O. SITCHEVSKA.

Methods of Examination

AMOUNT OF EYE MOVEMENT OBJECTIVELY PERCEPTIBLE TO THE UNAIDED EYE. E. LUDVIGH, Am. J. Ophth. **32:** 649 (May) 1949.

Ludvigh concludes from his investigations that if it is desired to detect ocular movements of 1 degree or less a subjective test should be employed or the examiner should use magnification.

W. S. REESE.

THE CORNEA IN POLARISED LIGHTS: PRELIMINARY COMMUNICATION. A. STANWORTH, Brit. J. Ophth. 33: 485 (Aug.) 1949.

On account of its transparency, the cornea is an attractive medium for studying the technic of photoelastic analysis as a method of studying stresses, especially in relation to the effects of a rise in intraocular pressure. The object of the article is to describe the possibilities of the method. The principles of photoelasticity are described, and the stress-optical coefficient of strips of cornea is determined. The value obtained shows that the birefringence of the corneal lamellas changes rapidly with elongation of the strips, and hence also with the intraocular pressure. The possible use of this phenomenon as a basis for a purely optical method of measuring changes in the intraocular pressure, and as a method of studying the molecular structure of the cornea, is described.

W. ZENTMAYER.

Neurology

STURGE-WEBER SYNDROME WITH MELANOSIS OCULI. J. ARJONA, Arch. Soc. oftal. hispano-am. 8: 1207 (Dec.) 1948.

After discussing fully the etiology and symptomatology of the Sturge-Weber syndrome, Arjona reports a case of his own which presented special characteristics. A boy aged 13 with oxycephaly and subnormal mentality presented nevus flammeus of both sides of the face and other parts of the body, hydrophthalmos of the left eye and congenital glaucoma of the right eye, convulsions involving the right side of the body and blue scleras. The roentgenograms showed calcareous changes in the occipital lobe of the brain. The blue scleras were produced by melanosis of this coat. According to the author, this symptom has not been mentioned in connection with the syndrome before except in a case reported by Ida Mann, in which the condition occurred with nevus flammeus, but without the other symptoms of the syndrome.

The bilaterality of the nevus flammeus and ocular symptoms, and the occurrence of blue scleras, which the author considers a part of the syndrome, are the unusual features of the case. The article contains a bibliography and is illustrated.

H. F. CARRASQUILLO.

CHANGES IN THE EYE IN TUBERCULOUS MENINGITIS DURING TREATMENT WITH STREPTOMYCIN. A. KLIVANSKAYA, Vestnik oftal. 28: 20, 1949.

Numerous examinations were made on 34 children (aged from 2½ to 12 years) who were under treatment with streptomycin for tuberculous meningitis. The pupillary and motor disturbances were unstable and usually improved whenever the general condition improved. The changes most frequently observed were papilledema (18 cases) and optic neuritis (1 case). This is in contradiction to the reports in the literature of prevalence of optic neuritis and the rarity of papilledema in association with tuberculous meningitis. Klivanskaya questions whether the papilledema frequently observed was due to increased intracranial pressure or to the treatment with streptomycin. Another interesting observation was the narrowing of both arteries and veins in the presence of papilledema. The author suggests the possible specific antispastic action of streptomycin.

In 4 children who showed general improvement the swelling of the disks disappeared and vision remained good. In some cases, despite prolonged remissions, the disks remained swollen and an exacerbation of the process set in later, so that the condition of the disk could be considered a most unfavorable prognostic sign. In 4 very young children tubercles of the choroid were observed in one eye. In 1 child minute hemorrhages of the retina appeared three days before death.

O. SITCHEVSKA.

MYASTHENIA GRAVIS: REPORT OF A CASE. N. PLETNEVA, Vestnik. oftal. **28:** 38, 1949.

A man aged 56 had variable ptosis of the left eyelid; six months later there was bilateral ptosis with diplopia. No other neurologic symptoms were present, and only when weakness of the muscles of the legs and hands appeared was the diagnosis of myasthenia gravis made. Neostigmine had a favorable therapeutic effect, the improvement also perhaps being due to the irradiation of the thymus; however, the ptosis and diplopia were unchanged.

This case is reported in order that the attention of ophthalmologists may be called to the fact that the ocular muscles may occasionally be affected first in myasthenia gravis.

O. SITCHEVSKA.

Ocular Muscles

FUSIONAL VERGENCE. E. F. TAIT, Am. J. Ophth. **32:** 1223 (Sept.) 1949.

Tait presents the data on prism convergence and prism divergence trials made on 500 adult clinical subjects.

These data are interpreted in terms of the source of the stimuli for the motor responses noted. The function of the perimacular fusional receptors and the extramacular fusional receptors, those farther in the periphery, is discussed. The data suggest that the function of the perimacular group is to retain fusion when once established, whereas the function of the extramacular group is to aid in establishing or gaining fusion.

The development of the use-amplitude fraction and its application in the diagnosis of binocular dysfunction are presented.

W. S. REESE.

THE PRINCIPLE OF MANIFOLD COOPERATIONS AMONG THE OCULAR MUSCLES. ARMIN VON TSCHERMAK-SEYSENEGG, Arch. f. Ophth. **148:** 10 (Sept.) 1947.

The author restates briefly the principle of manifold synergisms between ocular muscles. The original detailed presentation of this principle can be found in the essayist's chapter on ocular motility in Bethe's "Handbuch der normalen und pathologischen Physiologie" (Berlin, Julius Springer, 1929). An example of the manifold cooperations follows: Monocularly, the superior rectus cooperates with the inferior oblique to produce pure elevation but chooses the superior oblique for a partner if the object is intorsion. Similar, manifold cooperations occur during binocular coordinated movements.

P. C. KRONFELD.

Operations

SUTURES USED IN CATARACT SURGERY: A REVIEW. D. P. BELL, Am. J. Ophth. **32**:639 (May) 1949.

Bell concludes that sutures should be used for cataract operations, that the corneoscleral type affords the best closure and that silk is the best suture material.

W. S. REESE.

REOPENING OF WOUNDS AFTER CATARACT EXTRACTION. H. FANTA, Ophthalmologica **116**: 149 (Sept.) 1948.

Before the introduction of the scleral or the corneoscleral suture, the reopening of wounds after cataract extraction occurred oftenest on the sixth day. Statistics from Dr. Lindner's clinic in Vienna show a 30 per cent incidence of reopening before the introduction of the scleral suture both for intracapsular and for extracapsular extractions. The incidence was considerably reduced after introduction of the scleral suture, and prolapse of the iris was reduced from 3 to 0.1 per cent of cases. The patients always walk back to their rooms after the operation, and the suture was found to be a considerable safeguard during the period of air raids, when the patients had to walk into the basement several times a day after the operation.

H. P. KIRBER.

Pharmacology

HEPARINIZATION OF THE EYE. M. W. BICK, Am. J. Ophth. **32**: 663 (May) 1949.

Bick gives a brief review of the pertinent facts regarding heparin. The relation of dosage, blood concentration and coagulation in the rabbit was studied. The manner in which heparin enters and leaves the intraocular fluid was investigated. It is concluded that the most practical and certain method of heparinizing the eye is by the direct introduction of heparin

W. S. REESE.

LOCAL ACTION OF ZINC SULFATE. W. JAHNKE, Arch. f. Ophth. **148**: 775 (Dec.) 1948.

Contrary to general opinion, the beneficial action of zinc sulfate on chronic conjunctivitis is not that of an astringent but, rather, that of an irritant which restores the ability of the tissue to react to various stimuli.

P. C. KRONFELD.

Physiology

ROLE OF THE TRIGEMINAL NERVE IN REGULATION OF INTRAOCULAR TENSION. A. MOREU, Arch. Soc. oftal. hispano-am. **8**: 1193 (Dec.) 1948.

Moreu experimented on dogs to determine the action of the fifth nerve on the intraocular tension. To eliminate the possible action of the third nerve, the animals were curarized. No anesthesia was used. Fine needles were passed into the eye at the corneoscleral angle to

stimulate the iris and the ciliary body. Stimulation of the iris in this manner produced hyperemia of the ciliary zone, increase in intraocular tension, miosis, hyperemia of the iris and ciliary body and flocculation of the aqueous humor, brought about by an increase in the capillary permeability. All these changes except the injection of the ciliary zone returned to normal in less than twenty-four hours. The experiment was repeated by modifying the neurovegetative tonus of the eye by use of mimetic or lytic drugs. It was found that the parasympathicomimetic drugs increased the effectiveness of the experiment, while the parasympathicolytic agents had no action.

When the sympathicomimetic drugs were administered, no effect followed the stimulation of the trigeminus, while by the use of sympathicolytic drugs or by resection of the sympathetic fibers the action of the nerve when stimulated was accentuated. In none of the experiments was permanent hypertension of the glaucomatous type obtained. However, abrupt hypertension, similar to acute tensional decompensation, was obtained by partially blocking the vorticose veins and then stimulating the fifth nerve.

It was also proved that stimulation of the trigeminus is accompanied with an increase in the permeability of the ciliary barrier. This did not occur when the globe was anesthetized. H. F. Carrasquillo.

The Embryologic Approach to the Problem of Ocular Tension. R. Sondermann, Arch. f. Ophth. **148:** 331 (March) 1948.

One of the most characteristic features of the eye is its state of tension, which, according to Sondermann, is produced not by any chemical process but by a gradual intrauterine reduction of the venous outflow, due to the progressive solidification of the sclera. A similar mechanism may account for the intracranial pressure. P. C. Kronfeld.

Course of Adaptation and Readaptation of the Eye and the Ear. E. G. A. von Beuningen, Arch. f. Ophth. **149:** 230 (April) 1949.

Readaptation implies the fluctuations of the light threshold which occur in a fully dark-adapted human eye subsequent to a short exposure to a light stimulus of about 150 lux (the "interrupting light"). If this exposure does not last more than five seconds, the light sensitivity during the process of readaptation increases to a level above that prevailing prior to the interrupting light. This phenomenon may be said to be one of sensitization by the interrupting light. Similar observations have been made on the human ear (Pattie, F. A., Jr.: *Am. J. Psychol.* **38:** 39, 1927). P. C. Kronfeld.

Refraction and Accommodation

Hereditary Myopia in Identical Twins. R. A. Burns, Brit. J. Ophth. **33:** 491 (Aug.) 1949.

At the time of the examinations the sisters were 51 years of age. They began school at the age of 5 and always had to sit close to the blackboard. They were found to be myopic at that time. The correction for Rose's eyes was -22.00 sph. $\bigcirc +1.50$ cyl., axis 95 for the right eye

and — 15.00 sph. ⌒ + 2.00 cyl., axis 80 for the left eye; that for May's eyes was — 22.00 sph. ⌒ + 1.50 cyl., axis 90 for the right eye and — 24.00 sph. ⌒ + 6.00 cyl., axis 100 for the left eye. The fundus picture was equally developed in all four eyes—high myopia at the posterior pole and moderate myopia at the periphery; large myopic crescents surrounding the disk but not involving the macula, which showed pigmentary mottling; evidence of arteriosclerosis, and extensive choroidal atrophy at the posterior pole. The pedigree showing direct transmission of the defect over three generations is evidence of its genetic origin.

W. ZENTMAYER.

HIGH VISUAL ACUITY WITH ABNORMAL OCULAR REFRACTION. M. DE RIVAS CHERIF, An. Soc. mex. de oftal. y oto-rino-laring. **22:** 37 (Jan.-March) 1948.

Diminished visual acuity should not be the sole guide in the diagnosis of a refractive error. Frequently there is abnormal refraction with normal, or above normal, vision.

The author has proved this fact by the study of 1,519 cases of refraction in his private practice. In 337 of these cases, or 21.93 per cent, vision in the worse eye was 1 or above 1. The number of males and females in the series was about equal, and their ages ranged from 7 to 64 years, the largest number being between 30 and 40 years of age.

The errors and their incidence were as follows: hypermetropia, 57 cases, or 8.71 per cent; compound hypermetropic astigmatism, 153 cases, or 23.39 per cent; simple hypermetropic astigmatism, 359 cases, or 54.82 per cent; mixed astigmatism, 25 cases, or 3.93 per cent; simple myopic astigmatism, 52 cases, or 7.95 per cent; compound myopic astigmatism, 6 cases, or 0.91 per cent. Two eyes were emmetropic, and none had myopia.

The amount of total astigmatism in the series was from 0.25 to as much as 1.75 D., the larger number of cases, 86.25 per cent, having the lower values.

There being no low visual acuity, the refractive errors were suspected on the basis of the symptoms. Almost every one was cured by wearing the proper correction.

As many patients showed biastigmatism, the author believes that the subjective ophthalmometric method devised by Marquez should be the method of choice in refraction of patients who have good visual acuity and present symptoms presumably due to a refractive error.

H. F. CARRASQUILLO.

A QUANTITATIVE THEORY OF RETINOSCOPY. H. LITTMANN, Arch. f. Ophth. **148:** 658 (Dec.) 1948.

The author of the paper, apparently a physicist of the Zeiss laboratories, has studied the fundamental processes of retinoscopy from the standpoint of quantitative mathematics. The details of his analysis were published in the German optical journal *Optik* in 1948. The paper under review is a short abstract intended for the ophthalmologist. Even in this abridged form, the paper does not lend itself

to abstracting, for the mathematical formulas would be unintelligible without the rather involved drawings and tracings, which are the most instructive part of the paper.

P. C. KRONFELD.

Retina and Optic Nerve

EXPERIMENTAL STUDIES OF THE EFFECTS OF ARTIFICIAL OCULAR HYPERTENSION ON THE FUNCTION OF THE RETINA. P. CIBIS and G. HOCHGESCHURZ, Arch. f. Ophth. **148**: 752 (Dec.) 1948.

In volunteers the ocular tension was raised artificially for periods up to one minute by the application to the sclera of an instrument similar to Bailliart's ophthalmodynamometer. In one series the ocular tension was raised to the level of the diastolic retinal arterial pressure, and in another series, to the level of the systolic retinal arterial pressure. The approximate Schiøtz equivalents of the two levels were 43 and 70 mm. respectively. During and after the application of the ophthalmodynamometer, the visual acuity was determined by means of several devices. While the ocular tension was being raised to the level of the diastolic retinal arterial pressure, the visual acuity dropped to a level of about 0.2 and returned to normal within several minutes after cessation of the artificial hypertension. If the ocular tension was raised to the level of the systolic arterial retinal pressure, visual acuity, within a few seconds, decreased to the level of amaurosis. About five seconds after the cessation of the pressure, vision began to return, again to reach its initial level within a few minutes. Only in 1 case did it take a whole hour for the visual acuity to return to the initial level. Determinations of visual fields during a period of artificial hypertension equal to about 45 mm. (Schiøtz) showed moderate, but definite, constriction for colors with very slight enlargement of the blindspot. The authors believe that this temporary loss of function is related to the circulatory disturbance caused by the sudden rise in ocular tension.

P. C. KRONFELD.

HEREDITARY OPTIC ATROPHY IN WOMEN. W. FRIEMANN, Arch. f. Ophth. **149**: 266 (April) 1949.

A hereditary optic nerve atrophy occurred in several female members of two consecutive generations, preceded and followed by normal generations. Not a single male member was affected. The disease had its gradual onset at ages 18 to 23. The disturbance may be related to Leber's hereditary optic atrophy. Its course is apparently modified by hormonal factors.

P. C. KRONFELD.

Therapeutics

TREATMENT OF CERTAIN VASCULAR DISEASES OF THE EYE WITH RETROBULBAR INJECTION OF NICOTINIC ACID. E. HARTMANN and R. ROSSANO, Bull. Soc. d'opht. de Paris **2**: 51 (Feb.) 1948.

This is a preliminary report of the authors' experiences in the use of retrobulbar injection of nicotinic acid, some of which were favorable and some unfavorable. A previous report was made by Rossano in 1947. The vascular disorders fall in the following categories: obliteration of the

central retinal artery, thrombosis of the central vein, and a complex group with arteriosclerotic retinopathy. No complications or accidents occurred in the course of 300 retrobulbar injections. As a rule, the best results were obtained with thrombosis of the central vein and the poorest results with obliteration of the central artery.

L. L. MAYER.

CITRIN (FACTOR P) IN OPHTHALMOLOGIC THERAPEUTICS. M. PELAYO MARTIN, Arch. Soc. oftal. hispano-am. **7**: 1129 (Nov.) 1947.

Citrin, or vitamin P, which contains chiefly hesperidin and eriodictyol, has the important therapeutic property of regulating and normalizing the capillary permeability and increasing the capillary resistance. It can be administered by mouth, hypodermically or intravenously. Frequently a general reaction accompanies the intravenous injection. Its use in ophthalmology is indicated whenever there is excessive capillary fragility or permeability, such as occurs in serous inflammation or hemorrhage in the capillary areas. The following conditions in which vitamin P, alone or associated with ascorbic acid or other medicament, is beneficial are enumerated by the author: (*a*) cutaneous disorders of the lids, acute and chronic eczema, impetiginous eczema, urticaria, neurodermatitis, allergic dermatosis, erythroderma of neoarsphenamine intoxication, angioneurotic edema, chronic erythema of the vascular purpuras, acneform manifestations and blepharitis; (*b*) eczematous conjunctivitis, serous chemosis of allergic conjunctivitis, spontaneous recurrent conjunctival ecchymosis and acneform conjunctivitis; (*c*) serous tenonitis; (*d*) serous recurrent torpid cyclitis; (*e*) iritis of diverse origin; (*f*) postoperative hyphema after cataract operation; (*g*) all hemorrhages in the anterior chamber and hemorrhagic infiltration of the cornea; (*h*) focal or diffuse choroiditis; (*i*) papillitis; (*j*) acute glaucoma; (*k*) vitreous opacities.

H. F. CARRASQUILLO.

TREATMENT OF DIABETIC RETINOPATHY WITH INSULIN. W. JAHNKE, Arch. f. Ophth. **149**: 240 (April) 1949.

The author takes issue with the statements of Braun (*Arch. f. Ophth.* **136**, 1937) that insulin has no injurious effects on the retina, but also no favorable effect on diabetic retinopathy. Jahnke argues that since the life span of diabetic patients has been greatly prolonged by insulin therapy the incidence of retinopathy would have to be higher now than in the preinsulin era if the insulin had no effect at all on the retinopathy. The fact that the incidence of retinopathy has remained the same, notwithstanding the greater life expectancy of the diabetic patient, indicates a favorable effect of insulin on the retinal disease.

Large single doses of insulin may be injurious to the retina by causing sudden vasodilation and abnormal vascular permeability. Insulin should be used in divided doses, carefully calculated to avoid rapid changes in the blood sugar. The retinal hemorrhages seen in diabetic persons may be due to a factor other than diabetes. Ascorbic acid plays an important part in the treatment of the retinopathy. The author recommends that "a well thought-out plan of therapy be instituted at the first sign of retinopathy" and deprecates the pessimistic attitude of most ophthalmologists. Hypercholesteremia may be more injurious to the retina than the hyperglycemia.

P. C. KRONFELD.

Uvea

ESSENTIAL PROGRESSIVE ATROPHY OF THE IRIS. L. W. CHANG and G. W. OJERS, Am. J. Ophth. 32: 369 (March) 1949.

Chang and Ojers report 3 cases of essential atrophy of the iris.

Peripheral anterior synechias were demonstrated by either slit lamp microscopy or gonioscopy (or both) in cases 1 and 2. It is felt that anterior synechias were probably present in case 3 because of the presence of secondary glaucoma. The peripheral anterior synechias in the first 2 cases were so situated that the atrophy of the iris could well have been due to the mechanical displacement and subsequent stress on the iris.

W. S. REESE.

PAST HISTORY AND GENERAL SUSCEPTIBILITY TO DISEASE OF PATIENTS WITH UVEITIS OR KERATITIS. K. VOM HOFE, Arch. f. Ophth. **149:** 220 (April) 1949.

The data reported by the author suggest a higher incidence of other (extraocular) inflammatory diseases in the histories of patients with uveitis than in control patients. During the course of the ocular inflammation the patient thus affected is, according to the author, more susceptible to other inflammatory diseases than is a control patient. A positive history of pulmonary disease is obtained more frequently in cases of uveitis than in control cases. The author concludes that the etiology and pathogenesis of uveitis are complex processes.

P. C. KRONFELD.

Vision

FIXATION DISPARITY AND THE FUSIONAL PROCESSES IN BINOCULAR SINGLE VISION. K. OGLE, F. MUSSEY and A. PRANGEN, Am. J. Ophth. **32:** 1069 (Aug.) 1949.

Ogle, Mussey and Prangen find that fixation disparity is an indication, if not an actual measure, of the muscular imbalance when the images in the two eyes are fused. Its magnitude depends not only on the stress of that muscular imbalance but also on the strength of the fusional reflex process.

W. S. REESE.

ILLUMINATION OF THE SNELLEN CHART. M. GILBERT and R. G. HOPKINSON, Brit. J. Ophth. **33:** 305 (May) 1949.

As a result of carefully conducted experiments, the authors have determined that an increase in illumination of the order of 10:1 improves the visual acuity by one line on the Snellen chart. The effect is rather less for observers with good vision than for those with poor vision, especially for high levels of illumination. The data suggest that it is necessary to set some standard of illumination of the Snellen chart, especially when this is used as a passing test of visual acuity for entrants to a trade or profession.

W. ZENTMAYER.

AN OBJECTIVE VISUAL ACUITY TEST. G. GUENTHER, Arch. f. Ophth. **148:** 430 (July) 1948.

This is a modification of the method of Ohm and Goldmann, the principle of which is the determination of the smaller pattern that

produces definite optokinetic nystagmus. In "cooperative" subjects there is close correlation between the visual acuity determined by this objective test and that determined by the conventional subjective method. The author's instrument is applicable to visual acuities ranging from 3/100 to 1.3.

P. C. KRONFELD.

STENOPEIC VISION. K. MAJEWSKI, Klin. Oczna 18:68, 1948.

Contrary to the perimetric test, examination with the stenopeic hole refers to the central part of the retina. By elimination of diffusion circles, a sharper picture is obtained. The color appears of the same quality but sharper. The depth perception is improved. There is similar vision in pathologic conditions of the eye in which the field is restricted to the central part, as in pigmentary degeneration, atrophy of the optic nerve or bilateral hemianopsia with sparing of the macula. Interesting is the lack of dark adaptation with stenopeic vision, because of the lack of rods in the macula. The clinical application of stenopeic vision is (1) quick determination of central vision and (2) determination of the best location for optical iridectomy in cases of leukoma.

S. SCHULSINGER.

Society Transactions

EDITED BY DR. W. L. BENEDICT

AMERICAN OPHTHALMOLOGICAL SOCIETY

Bernard Samuels, M.D., *President*

Maynard C. Wheeler, M.D., *Secretary-Treasurer*

May 17, 18 and 19, 1948

Cataracts and Tetany Produced by Parathyroid Deficiency During Pregnancy, Lactation and Menstruation. DR. DONALD J. LYLE, Cincinnati.

A white woman aged 28 was examined because of failing vision in both eyes. Discrete posterior subcapsular opacities were found bilaterally. Chvostek and Trousseau signs and a low serum calcium, of 7 mg. per hundred cubic centimeters, established the diagnosis of idiopathic thyroid deficiency. There was no history of any disturbance before the first pregnancy. The idiopathic deficiency which existed at a latent asymptomatic level was aggravated by two pregnancies and periods of lactation, and subsequently even by menstruation, to the manifest symptomatic level.

DISCUSSION

DR. J. A. MCMILLAN, Montreal, Canada: As Dr. Lyle points out, relatively few cases of idiopathic hypoparathyroidism have been described in man. The condition is well known, however, in veterinary medicine under the name of "milk fever," which occurs commonly in dairy cows, and less frequently in mares, goats, ewes and sows. It is associated with acute hypocalcemia, which is quickly overcome by the injection of readily assimilable calcium salts. Hypocalcemia would seem to be a better term for this condition than idiopathic hypoparathyroidism, because of the many physiologic variants influencing blood calcium. The history of impaired vision during menstruation is not in conformity with the fact that the loss of calcium in the menstrual blood is not sufficient to affect appreciably the serum calcium. Has Dr. Lyle any positive data to substantiate the history?

DR. DONALD J. LYLE, Cincinnati: After each pregnancy and period of lactation the blood calcium is readjusted at a lower level. In a person with hypoparathyroidism, it may through several pregnancies reach the symptomatic level, or a level just above it, so close that even the slightest menstrual disturbance produces symptoms.

Scleral Staphyloma and Retinal Detachment. DR. DERRICK VAIL, Chicago.

In 1940 I reported before this society a case of equatorial scleral staphyloma and retinal detachment in which a successful cure was effected by incision of the staphyloma. In 1945 the patient's second eye became similarly affected and was successfully treated in the same

manner. Since then, in a recent series of 34 cases of retinal detachment, I have operated in 8 additional cases of scleral staphyloma and retinal detachment. This series indicates that the combination of the two conditions is perhaps not infrequent. So far as could be determined, these cases are the first of this association which have been reported. In most of the cases the detachment was dark and ballooned, with a large, horseshoe-shaped tear. Unless the staphyloma is small, diathermy alone offers the least chance of a successful result. Excision of the staphyloma by first tucking the affected sclera is relatively simple; diathermy punctures can be placed around the wound, thus increasing the chances of success and reducing the hazard of intraocular hemorrhage. The diagnosis is made by the bluish, bulging appearance of the affected sclera, the easy indentation of its surface and its increased transparency on transillumination.

DISCUSSION

Dr. Algernon B. Reese, New York: I have observed the lesion described by Dr. Vail at least twice. I believe that the retinal detachment is secondary to the inflammation in the choroid and that the same type of inflammation in the adjacent sclera leads to ectasia. I believe that diathermy would be adequate in cases in which the area of ectasia is not large, because surface diathermy of the sclera produces an extensive flattening of that structure.

Dr. Alexander E. McDonald, Toronto, Canada: In a case in which I operated, the postoperative anterior chamber was very deep; I should like to ask Dr. Vail whether he encountered this complication.

Dr. Daniel E. Kirby, New York: I wish to confirm Dr. Reese's observation that a small staphyloma can be cured with surface diathermy.

Dr. Georgiana Dvorak Theobald, Oak Park, Ill.: The terms staphyloma and ectasia are used rather loosely. Dr. Vail's first slide shows an ectasia, as the stretched sclera is not lined with pigment.

Dr. Derrick Vail, Chicago: The operation is exceedingly difficult, especially after previous diathermy. I have also noticed the deepening of the anterior chamber following the excision of a large staphyloma. This may be due to a reduction of the volume of the vitreous, as a result of evacuation of the subretinal fluid.

Herniation of the Anterior Hyaloid Membrane Following Uncomplicated Cataract Extraction. Dr. Algernon B. Reese, New York.

Contact of the membrane with the cornea usually causes irritation of the eye, giving a clinical appearance of mild iridocyclitis. Edema of the corneal stroma and overlying epithelium results from aqueous penetrating the disturbed endothelium; if cornea guttata is present, permanent opacification may result. The condition clears promptly with the use of miotics. Usually the herniation of the hyaloid membrane disappears spontaneously. The contact of the membrane with the cornea is a cause of striate keratitis, which is seen at the first dressing. A strong miotic, such as di-isopropyl fluorophosphate, should be used in such cases. If the herniation is large, the miotic may not accomplish complete regression of the hyaloid membrane, but may trap a collar-button-shaped knuckle in the anterior chamber; in such a case the patient should be

put to bed on his back and the pupil dilated widely with 10 per cent phenylephrine hydrochloride (neo-synephrine® hydrochloride) and then reconstricted with a miotic. In intractable cases the patient should be put to bed on his back, the pupil dilated with phenylephrine, and air or Ringer's solution injected into the anterior chamber, followed by the instillation of di-isopropyl fluorophosphate. Failure of restoration of the anterior chamber or its loss may be due to advancement of the hyaloid membrane into the anterior chamber. Besides the usual type of prolapse of the iris following cataract extraction, due to sudden rupture of the wound, there is a type caused by herniation of the anterior hyaloid membrane, which pushes the iris ahead of it into the separated edges of the wound; the onset is insidious, and it may occur at any time after the operation. The development of a late coloboma after an uncomplicated round pupil extraction is due in some cases to herniation of the anterior hyaloid membrane, which pushes the iris peripherally. Secondary glaucoma may ensue because the anterior hyaloid membrane herniates sufficiently at the periphery to push forward the iris and block the angle, or because the membrane itself blocks the angle, over the site of a coloboma of the iris. The glaucoma that may follow a round pupil extraction may be due to the protrusion of the membrane in a pyramidal fashion through the pupillary area, causing a ball and valve effect.

DISCUSSION

Dr. Edwin B. Dunphy, Boston: Although many ophthalmologists are aware that vitreous in contact with the corneal endothelium for any length of time may give rise to corneal edema, its occurrence in my experience has been extremely rare, considering the presence of herniation of the vitreous. Since striate keratitis occurs frequently after extracapsular, as well as intracapsular, extraction, it is my impression that it is caused not by the contact of the vitreous with the cornea, but by damage to the corneal endothelium during the operation. I have not seen the saucer-shaped corneal opacity described by Dr. Reese in the few cases of delayed restoration of the anterior chamber in my experience. Unlike Dr. Reese, Cogan, who has been making a study of corneal edema, stated the belief that this condition may result also from the contact of free vitreous with the cornea, and that the determining factor is the condition of the corneal endothelium.

Dr. F. H. Verhoeff, Boston: In a case of corneal opacification due to adherence of vitreous to the posterior corneal surface, I made a keratome incision, let out all the vitreous that would come, irrigated the anterior chamber, without the loss of further vitreous, and closed the wound with a suture. The cornea cleared, but the pupil became drawn up so high that it was practically invisible and required an iridotomy seven months later, when the inflammatory condition of the eye subsided. I suspect that a slight loss of vitreous is more likely to produce this condition than an extensive loss.

Dr. William P. Beetham, Boston: In cases in which serious corneal damage has occurred, injection of air is apt to be disappointing, but the adherence of the hyaloid membrane to the cornea can be prevented by an injection of air into the anterior chamber at the conclusion of the operation.

Dr. Charles A. Perera, New York: In a man aged 81 who had had a round pupil cataract extraction with injection of air, a hemorrhage in the anterior chamber and the vitreous was found on the first postoperative dressing. A small prolapse of the iris and striate keratitis were observed when the blood was absorbed sufficiently to permit inspection; the blood-filled vitreous pressed against the cornea. The cornea promptly cleared after an injection of air.

Dr. Ralph O. Rychener, Memphis, Tenn.: When Dr. Reese dilates the pupil with phenylephrine and constricts it with a strong miotic, how long does he use the miotic, and what happens after he discontinues it?

Dr. Alfred Cowan, Philadelphia: It seems to me that it is a matter not of pressure from behind, but, rather, of lack of pressure or of support in front.

Dr. Algernon B. Reese, New York: In answer to Dr. Rychener, a period of two to three days is adequate.

Effect of Dicumarol on the Visual Fields in Glaucoma: A Preliminary Report. Dr. William P. McGuire, Winchester, Va.

It would seem that the most reasonable explanation for the progressive changes in field in chronic simple glaucoma is arteriosclerotic alterations in the nutrient vessels of the optic nerve. These changes may involve slowing of the blood stream, narrowing of the lumen of the vessels and formation of mural thrombi. It would seem that a drug with both vasodilating and anticoagulant properties might be of value in cases of this type. The only drug which meets both these requirements is dicumarol. The method used consisted in hospitalizing the patient and administering 300 mg. of dicumarol by mouth. The amount of the drug to be given thereafter is determined by the prothrombin time reported on that day, usually 100 mg. In the 9 cases reported, dicumarol was initially administered for a period of two weeks. In 6 cases improvement in the visual fields was present several months or years after the tension had been reduced surgically, but the field changes showed continued progression.

DISCUSSION

Dr. P. A. Chandler, Boston: The cause of the continued loss of field after operation, with normalization of tension, is a controversial subject. I feel that the relation of the ocular tension to the strength of the disk in the individual case is the important factor, and that in the majority of cases of postoperative continued loss of field the tension will be 17, 22 or 25 mm. All have observed patients who after operation for advanced glaucoma, with a small field, might be expected to have continued loss of field but have not. The majority of patients who did not continue to lose field had postoperative hypotony, with a tension of 6, 8, 10 or 12 mm. It may well be that cupping has become well established and that it requires less pressure to cause further weakening of the disk.

Dr. McGuire suggests that the mechanism which makes the treatment effective consists in changes in the nutrient vessels of the optic nerve. The improvement could well be due, however, to a change in the

nutrient vessels of the lamina, so that he has through his treatment succeeded, in part at least, in strengthening the optic disk and thus preventing further cupping, with subsequent atrophy

Dr. Alexander E. McDonald, Toronto, Canada: Our enthusiasm to obtain results such as Dr. McGuire has shown should be well considered, because dicumarol is a fairly dangerous drug.

Dr. A. L. MacLean, Baltimore: After a period of administration of dicumarol for other conditions in a case of glaucoma simplex, the omission of miotics was followed by normal tension for five days.

A possible explanation of progressive loss of visual field following successful reduction of intraocular tension by operation is "blood sludging." This process, once started, might continue, but would be checked by the anticoagulant effects of dicumarol. Certainly, dicumarol does not retard sclerotic processes, and measurements of dilation of blood vessels following its administration have not been satisfactory. There are no conclusive reports on the dilating effects of clinical doses of the drug in human subjects.

As to the dosage, I again find myself at variance with Dr. McGuire. I believe that raising the prothrombin time to thirty-five or forty-five seconds is extremely hazardous. A safe and effective level is twenty or twenty-five seconds. Patients can be maintained at this level for indefinite periods, even as long as two to three years, without harmful effects. Furthermore, hospitalization is not necessary. After initial determinations every two days for a week or more, determinations of prothrombin time are necessary only every one to two weeks

Dr. William P. McGuire, Winchester, Va.: The cupping of the disk was seen to remain constant after use of dicumarol. The color of the disk almost always improved.

Keratoplasty in Treatment of Keratoconus. Dr. Ramon Castroviejo, New York.

The minimum size of the graft should be 6 mm. The graft must be large enough to substitute for all, or as much as possible, of the conus; otherwise the deformity is liable to advance. When the conus is off center, the graft should be displaced accordingly in order to remove as much as possible of the protruding area. If the pupil should fail to dilate beyond the limits of the area where the graft will be located in the cornea, it would be preferable to use a smaller graft or to prepare the eye with a large iridectomy, rather than to risk the development of anterior synechias, with subsequent danger of opacification of the graft and secondary glaucoma or both. If during the operation the iris shows within the opening, in spite of attempts to dilate the pupil, it is advisable to excise the involved portion of the iris and place sutures border to border. If anterior synechias develop, they must be loosened by the use of mydriatics or by surgical means, and this should be carried out in the third postoperative week. In eyes with keratoconus the transplant often has a tendency to protrude during the postoperative course. This must not be considered a complication, but almost a normal part of the cicatrization of grafts in cases of keratoconus. In order to obtain a more normal curvature, it is necessary to maintain a pressure dressing, which is applied on the fifteenth postoperative day and is continued until

the fifth or sixth postoperative week. During the first week of application of the pressure dressing the pressure must not be too strong; otherwise the incision may reopen. A transplant cloudy to the point at which the patient can see only to count fingers may clear up almost completely, with vision improving even to 20/20 within a year after the operation.

DISCUSSION

Dr. Ralph O. Rychener, Memphis, Tenn.: I have had 3 cases complicated by corneal hydrops in which improvement followed treatment by pressure dressings and repeated daily paracenteses. I believe that repeated paracenteses were an important part of the treatment.

Dr. Conrad Berens, New York: In thin corneas is it not better for the graft to extend anteriorly and posteriorly? Should one sew a graft in a thin cornea so firmly that the anterior surface of the graft is flush with the anterior surface of the cornea?

Dr. Ramon Castroviejo, New York: Dr. Rychener advocates paracentesis in cases of keratoconus in which acute hydrops has developed. I have successfully treated this complication by the application of a pressure dressing alone.

Surgical Anatomy of the Superior Oblique Muscle. Dr. W. H. Fink, Minneapolis.

The anatomy of the region of the tendon of the superior oblique muscle and its insertion was described in detail. In 100 dissections it was found that there is so much variation in the insertion of the tendon as to make it difficult for the surgeon to anticipate with any degree of accuracy what he may encounter. The dimensions and relations of this muscle to adjacent important structures, as determined by this study, were in fair agreement with the findings of other investigators.

In a consideration of the anatomy of this region from a surgical standpoint, certain factors are evident. Surgical procedures on the superior oblique muscle should be confined to the reflected tendon and its insertion. The anatomy of the area is such that operation on the direct portion of the muscle or the trochlea does not seem feasible. The approach to the muscle should be under the upper lid, in the region of insertion of the superior rectus muscle. From the anatomic standpoint, it is entirely possible that with the proper approach the superior rectus muscle can be retracted to expose the insertion of the superior oblique and the portion of its tendon which is beneath the superior rectus muscle. The tendon is practically avascular and fibrous and does not lend itself well to surgical procedures. It is friable and shreds easily. Any surgical procedure should, therefore, include the surrounding fascia bulbi, which will reenforce the freed tendon and give a more suitable tissue for healing.

DISCUSSION

Dr. Conrad Berens, New York: In transplanting the superior oblique for complete third nerve paralysis, it is well to keep in mind the important structures around the trochlear pulley. I had success with the first three operations in opening the pulley with a canaliculus knife, as suggested by Peter, but my last two (unhappy) experiences made me certain that in freeing the tendon one should approach the pulley from

a cutaneous incision, and Dr. Fink's clarification of the anatomy of the region makes me believe that my final decision is wise. In order to obtain elevating, as well as some adducting, action, I have sutured the tendon of the superior oblique between the superior and the medial rectus, instead of to the insertion of the medial rectus muscle, as usually advised.

It is usually desirable to resect the superior rectus in cases of third nerve paralysis because of the accompanying hypotropia. Therefore the finding of the tendon is not difficult.

In tucking and resecting the superior oblique, it is usually desirable to approach it from the temporal side, and it is generally unnecessary to tenotomize the superior rectus. In tucking, the tendon is brought temporally and sutured to the episclera with two 00000 blue nylon sutures, thus really advancing the tendon without freeing it from the sclera, where adhesions would occur if the insertion were not covered by Tenon's capsule.

If the anterior extremity of the insertion of the superior oblique is freed and a suture passed through it, the tendon may be gradually separated from its insertion, even though it does sometimes extend backward 13 or 14 mm. A second suture is inserted at the posterior extremity of the severed tendon.

Dr. William P. McGuire, Winchester, Va.: Dr. Fink states that a high percentage of the defects found in extraocular muscle balance are associated with the superior oblique muscle. There have been two schools of thought in regard to this. The first, that of White and Brown, held that the superior oblique was involved only in about 4 per cent of the cases of vertical muscle imbalance, while the second, that of Bielschowsky, held that the superior oblique was at fault in approximately 54 per cent. Such a discrepancy must have some explanation, and it is apparent that Bielschowsky referred to isolated primary vertical deviations, while White and Brown considered the whole field of muscular imbalances in arriving at their figures.

Dr. W. L. Hughes, Hempstead, L. I.: There are two places where the superior oblique may be effectively approached surgically. One is by altering the location of attachment of the trochlea, and the other, by operating on the tendon directly. The location of the trochlea can be either recessed, to reduce the function of the superior oblique, or advanced, to increase the action of the superior oblique. In most instances, I believe, the operation is better done directly on the reflected portion of the tendon of the muscle, after the technic of Berke.

Dr. Donald J. Lyle, Cincinnati: Surgical correction on the trochlea is occasionally indicated as a result of the extrinsic factors which dislocate it from its normal position, and operation is required in order to restore, at least in part, some of the lost function of the involved muscle. The operations may produce gratifying results.

A Simple Appositional Suture for Use in Operations for Cataract. Dr. Charles A. Perera, New York:

This paper was published in full in the September 1948 issue of the Archives, page 347.

DISCUSSION

DR. BRUCE FRALICK, Ann Arbor, Mich.: The advantages of corneoscleral sutures far outweigh their disadvantages, but sooner or later the sutures have to be removed. Their removal is often more difficult than the cataract extraction itself. I have used an absorbable 000000 chromic gut in 511 consecutive cataract extractions. This suture gives no more visible reaction than does 000000 silk. Two disadvantages in the use of this suture are its lack of flexibility and its similarity in color to the tissues. These are minor drawbacks.

DR. F. A. DAVIS, Madison, Wis.: Suturing of the deep wound is more difficult than suturing of the conjunctiva. Postoperative reaction is greater and more prolonged. Great care must be exercised in their removal. During the past two years I have used an adaptation of the Lindner and McLean stitch.

DR. F. H. VERHOEFF, Boston: The first suture to close the wound in a cataract operation was used in Boston, not by me, but by Williams. His could be called an appositional suture, too; but, so far as one can tell from his description, it was passed through the cornea into the anterior chamber. No one but Williams, so far as I can find, ever used that suture. I believe that I was the first to use a nonperforating appositional suture in a cataract operation. That was in 1927. I still think that my method is the best.

Therapy of Some Ocular Inflammations Based on Immunologic Principles. DR. F. HERBERT HAESSLER and DR. HERMAN A. HEISE (by invitation), Milwaukee.

Vaccine therapy is essentially the introduction of an antigen similar to the invading one into tissues of an organ other than the infected one. In practice this other tissue is almost always the skin, and the process has, unfortunately, been named "desensitization." Actually, one is not desensitizing the skin but, rather, is sensitizing, or immunizing, it. One is inducing it to become the site of an adequate supply of antibody. When treating an eye, one strives to inject antigen into the skin in such quantity that local antigen-antibody reactions will take place in the skin and humoral antigen-antibody reactions, which are harmless to the eye, will deplete the eye of antigen. Thus, the site of the harmful antigen-antibody reaction is shifted from the eye to the much less vulnerable skin. An excessive injection is dangerous because the excess of antigen can reach the diseased organ and increase the inflammatory process.

DISCUSSION

DR. A. LEMOINE, Kansas City, Mo.: The detailed fundamental mechanism involved in the reaction of the antibodies and antigen with tissue cells is extremely complex, and is not well understood by most of us. Dr. Heise and Dr. Haessler have presented the subject in a simplified manner, so as to make it understandable to physicians who do not have time to master the detailed principles involved in these reactions.

I agree with them that the interval between injections and the size of the dose are extremely important. In my experience, with a small

dose, an interval of five to seven days gives the best results, and I never permit the interval to exceed ten days. The quantity should never be large enough to give a focal reaction. In my hands, the intracutaneous injections give the best results, besides giving a much better index to the amount of the local reaction.

In cases of blepharoconjunctivitis that does not clear up and stay well with use of the antibiotics, use of an autogenous vaccine is probably the ideal treatment, but stock vaccine or the toxoid gives equally good results in most cases. In selected cases of chronic tuberculous uveitis, anterior nodular scleritis and interstitial keratitis, I have found immunization to the tuberculin a valuable therapeutic measure. Some patients with sudden onset of opacities in the vitreous which are rapidly growing worse, in whom we are unable to find a focus of infection or hemorrhage or any metabolic disturbance, and who are found to be extremely sensitive to the streptococcus, are benefited by a vaccine of streptococcus.

Primary Malignant Melanoma of the Optic Disk: Report of a Case. Dr. Frederick C. Cordes and Dr. Michael J. Hogan (by invitation), San Francisco.

A case of a primary malignant melanoma of the left optic disk in a Negro aged 52 was presented. The available literature revealed only 5 cases of primary malignant melanoma of the optic disk.

DISCUSSION

Dr. Algernon B. Reese, New York: I have examined the section in this case. There is no doubt about this being a primary melanoma of the disk. As Dr. Cordes mentioned, it is possible for a malignant melanoma to arise in the disk, because in highly pigmented persons, and sometimes in those not so highly pigmented, chromatoblasts may be present in the lamina cribrosa of eyes otherwise normal. Sometimes these chromatoblasts can be seen clinically in the base of the physiologic cup.

Dr. W. E. Fry, Philadelphia: Of 164 eyes enucleated at the Wills Hospital which contained malignant melanoma, the optic nerve was involved in 12. Histologic examination of these eyes showed that the changes in and about the disk were chiefly glial.

Martin Jones, in his monograph on sarcomas of the uvea, stated that it does not appear that involvement of the optic nerve by a malignant melanoma is necessarily a bad prognostic sign.

Dr. F. Phinizy Calhoun, Atlanta, Ga.: It is my observation that malignant melanoma, in any location, rarely occurs in the pure-blooded Negro. It would be interesting to learn the racial mixture of Dr. Cordes' patient.

Dr. Frederick C. Cordes, San Francisco: This patient, a Negro, showed definite evidence of having some white blood.

Dermoid and Epidermoid Tumors of the Orbit. Dr. Raymond L. Pfeiffer and Dr. R. J. Nicholl (by invitation), New York.

This paper was published in the December 1948 issue of the Archives, page 639.

DISCUSSION

DR. ARNOLD KNAPP, New York: Dr. Pfeiffer has demonstrated 9 cases of an interesting and important condition. The dermoid is a lesion of the orbit usually involving one of the bones, principally the frontal. The main feature is a defect in the bone with sharply defined and thickened margins, which gives a characteristic roentgenogram, so that the diagnosis can be made on that basis. The bony defect is filled with a soft mass, which has a firm envelop and contains semifluid material. The contents of the tumor classify the process as belonging to the group of dermoids. In 4 cases of mine which were characterized by a punched-out appearance of the frontal bone in the roentgenogram, like that which Dr. Pfeiffer has stressed, the bony defect was filled in with a soft mass containing a watery fluid. Dr. James Ewing classified the tumor as an example of xanthomatosis. I should like to ask Dr. Pfeiffer whether there was any evidence of xanthomatosis in his cases.

DR. BERNARD SAMUELS, New York: There are three congenital formations with skinlike structures in the orbit. A dermoid cyst is a cavity containing a fluid derived from the product of sebaceous or sweat glands, and not from its epithelial lining. An epidermoid differs from a dermoid cyst in that its avascular sheath contains no glands. Therefore, its content is composed solely of desquamated epithelium. A dermoid tumor is a solid formation the cuticular elements of which lie exposed on the surface of the body.

Formerly, the accidental rupture of the capsule in surgical procedures was considered a disaster. This is now done purposely to evacuate the content and, by phenolization, to destroy the epithelial structures in the wall of the sheath. The excision of the sheath itself seems to be a matter of secondary importance.

DR. RAYMOND L. PFEIFFER, New York: We have seen a number of xanthomas of the orbit in adults. These lesions are demonstrable roentgenologically and may resemble dermoids in the roentgenograms.

The Dupuy-Dutemps Dacryocystorhinostomy. DR. ALTON V. HALLUM, Atlanta, Ga.

Of 55 patients undergoing dacryocystorhinostomy who were followed after operation, only 2 reported no relief of pus or tearing. Six other patients were relieved of pus but not completely of tearing. In 4 of these patients the lower punctum was found at the follow-up examination to be dilated beyond normal size; 1 patient had the canaliculus slit, and 1 had occlusion of the lower punctum.

DISCUSSION

DR. P. A. CHANDLER, Boston: Some type of operation to provide a new pathway for drainage of the lacrimal sac into the nose has been employed almost routinely in Europe for twenty years or more. Such a procedure has been adopted much more slowly in the United States. Yet even in conservative Boston we ophthalmic surgeons have been doing it for a number of years. I can assure you that the excellent results reported by Dr. Hallum are not exaggerated, and I say this not only from my knowledge of Dr. Hallum's integrity but from my own experience and that of many others.

Extirpation of the lacrimal sac is a simpler operation, and I believe is to be preferred for most patients in the late seventies or eighties. In such persons, epiphora is usually not a troublesome symptom, either before or after operation.

I know of no operation in which one can anticipate success in such a high percentage of cases as in dacryocystorhinostomy.

DR. RALPH O. RYCHENER, Memphis, Tenn.: Some surgeons have been hesitant about doing this particular type of plastic surgery because of the difficulty sometimes encountered in engaging the lower flaps with the sutures. This can be easily overcome if, instead of using fancy needle holders, such as the Dupuy-Dutemps and Reverdi instruments, one takes a small straight mosquito hemostat and uses it as a needle holder, engaging the needle so that the needle is a prolongation of the hemostat. The needle is directed straight down into the hole in which one is working; the mucosal flaps can then be engaged with a great deal of ease, drawn together and tied.

I should like to call attention to the congenital origin of the defect in many cases. In 20 per cent of my own cases the condition is due to a congenital stenosis, and I make a plea for the relief of congenital stenosis in order to avoid the necessity for this operation later.

Secondary Subjective Effects Produced by Prisms. DR. WALTER B. LANCASTER, Boston.

The various optical distortions produced by prisms can be explained on the basis of the obliquity of incidence of the rays in two significant planes, the base-apex plane, called plane 1, a horizontal plane, and the vertical plane, parallel to the base and perpendicular to the first plane, called plane 2. The effects of these distortions can be classified as (*a*) the asymmetric effect of obliquity in the base-apex plane, (*b*) the obliquity effect of obliquity in the plane parallel to the base and (*c*) the stereoscopic effect of these in binocular vision.

The author's explanation of the obliquity effect was offered as a new contribution to the subject. When a prism is cut square across at right angles to the base and to the sides the cross section is a triangle of minimum base and minimum apical angle. When it is cut obliquely, but still at a right angle to the base, the triangular cross section has a longer base and therefore a larger apical angle. Therefore, it has more power to cause deviation than the minimum apical angle.

DISCUSSION

DR. A. COWAN, Philadelphia: In a pencil of light in which the axis of the pencil coincides with the axis of the lens, all the rays in each circle which are concentric with the axis will meet in a point. This never takes place in a prism. Just as the power of a lens is measured by the least refraction that takes place close to the axis, so in a prism the power is measured by the rays which are bent least—the minimum deviation. The ray which is the measure of minimum deviation forms an isosceles triangle with the sides of the prism in its passage through the prism. Each ray is refracted according to the obliquity of its incidence on the refracting surface. The aberration which Dr. Lancaster describes may be compared with the distortion by an ordinary convergent spherical lens. This

can be likened to an innumerable number of prisms with their bases in apposition. In that case the image of a square would be so distorted that the corners would be extended and it would take the shape of a pillow. In the case of a concave lens with the apexes all in apposition the image of a square would be so distorted that the corners would be shortened and it would resemble a barrel.

Cures for Myopia. Dr. S. Judd Beach, Portland, Maine.

The kernel of popular and unorthodox sight-training courses lies in the flashes of distinct vision they elicit. This is the feature that keeps the devotees faithful. As the clear vision frequently is monocular and shifts from one eye to the other, it cannot be ascribed to improved interpretation of blurred images on the cerebral level. In a sample case, it seemed to be a development of the squinting used by myopic patients to clear their sight. One observer concluded that this was the pinhole phenomenon; another thought the squinting shortened the globe. Myopic persons do not all squint alike. Use of the pinhole shows that in some cases there is gain apart from that obtained by narrowing the aperture. Use of akinesis of the orbicularis muscle and of retrobulbar akinesis of the extraocular muscles might give a clue to whether this is due to pressure by the orbicularis, squeezing or relaxation of the extrinsic musculature. A synergistic action is conceivable. It should not be surprising to find these effects produced in several ways.

DISCUSSION

Dr. Walter B. Lancaster, Boston: One cannot change the structure of the eye by exercises. One can teach people to see better. We ophthalmologists have not appreciated the importance of that. We have concentrated too much on getting men into the armed services and of keeping men out who ought not to be in. But in the civilian population, if we can teach a patient to see better in any other way than by wearing glasses, or to see better with his glasses, we are giving a great deal of satisfaction to that patient. We have not exhausted the possibilities. The quacks are paying more attention to it than we are. This paper is important if it will arouse interest not merely in myopia but in the general question of visual perception and of how it can be improved by training, by exercises and by methods other than purely optical ones.

Dr. S. Judd Beach, Portland, Maine: I wish to point out that Dr. Lancaster's work showing that sight training can improve observation has been confirmed by Dr. Post and Dr. Woods and brilliantly corroborated in the last war by Renfrew. Oculists have nevertheless jumped to the conclusion that the training explains all the good results. Actually, it is only part of the problem. I have mentioned that the skills are permanent and that alternating improvement of the two eyes is not cerebral. One could find out whether it is the lids or some other factor which produces the improvement in visual acuity, and I assume that retrobulbar injection might eliminate the extraocular muscles in some way. There is a tendency in examining large numbers of patients, to conclude that they are only improving their observation, whereas if a little time were devoted to some of the patients who do gain actual

increase in acuity one might get some answer to the questions which are asked by persons who take these sight-training courses. As a matter of fact, these patients know when they see vividly, as they do during what Bates calls central fixation, which is simply another name for the flashes of clear vision that they get. They know that if they see 20/10 vividly they are not simply distinguishing blurred images better, and they discount statements made by oculists, who they feel ought to be stuffed and put in museums.

Mechanics of Intracapsular Cataract Extraction. Dr. David O. Harrington, San Francisco.

This paper was published in the July 1949 issue of the Archives, page 23.

DISCUSSION

Dr. Arnold Knapp, New York: I was particularly impressed by the statement that the deflection of the vitreous which is necessary to dislocate the lens varies according to whether the vitreous body is solid or fluid. This introduces, however, a physical question, which requires further study.

I was not able to convince myself of the importance of the negative pressure by which the lens sticks to its patellar fossa. It has seemed to me that this is a force which is difficult to gage at operation; at the same time, I am firmly convinced that I have observed a number of cases in which there has been an adhesion between the capsule and the hyaloid membrane, which, of course, leads to rupture of the latter. It is important to remember that in the straightforward intracapsular cataract operation it is not simply by grasping the capsule and then exerting pressure at the lower corneal margin with the tip of the hook that the suspensory ligament is mechanically ruptured. The dislocation of the cataract must take place by the vis a tergo of the vitreous. I do not mean a lens cannot be dislocated by this procedure, but I maintain that it leads oftener to a ruptured capsule.

Dr. Daniel B. Kirby, New York: The conclusions and clinical surgical application I make from Dr. Harrington's investigations and my own research differ from his. I have stressed the futility of continuing to use pressure as a means of effecting rupture of the zonule unless this occurs easily and with point pressure applied in a precise manner inside the limbus of the cornea. Dr. Harrington found that 15 Gm. of pressure applied here caused the lens to tilt and present. This was the minimum of pressure he used in his experiments. It represents the maximum of pressure that I use. If this does not effect rupture, I proceed to simultaneous traction and pressure.

Dr. Harrington found that it took more pressure (20 to 40 Gm.), exerted outside the limbus, above or below, to produce rupture of the zonule. I do not deny that such external pressure will cause rupture of the zonule; the question is whether its use is desirable. Whether the vitreous is a tissue or not, it does not tolerate well the higher degrees of pressure, nor do the intervening tissues of the uvea. I believe that when I rupture the zonule by pressure alone exerted inside the ring of the cornea, I effect this with the point of the expressor instrument tilting the nucleus of the lens and then sliding off onto a very fragile zonule

(about 15 per cent of cases). I certainly would not agree that if this rupture does not occur it is well to exert pressure on the sclera over the ciliary body or choroid in order to push a wedge of vitreous up between the equator of the lens and the zonule. It is important to learn from fundamental research how to exert pressure, and Dr. Harrington has shown us the effects of this pressure. If he has been able to rupture the zonule by pressure alone without loss of vitreous and without too much disturbance of vitreous, he has made an important contribution to the method of zonular rupture by pressure. Common experience, however, is against the use of pressure alone.

Dr. David O. Harrington, San Francisco: I am grateful for Dr. Knapp's support backed by the authority of many years of experience in thousands of cataract extractions. I do not agree with most of Dr. Kirby's conclusions. The principle of simultaneous traction and pressure, with tension on the zonule so as to produce a gap, is important and is used in my method and in most methods of cataract extraction. This, however, does not mean that the zonule is ruptured by traction, but implies only that it is placed under tension, so that with pressure in the area of the tensed zonule the vitreous can more easily enter as a wedge to rupture the zonule. I still feel that the vitreous does the major part of the work in zonular rupture in most cases of intracapsular extraction.

Retinoblastoma in the Adult. Dr. Ralph O. Rychener, Memphis, Tenn.

This case is believed to be the fifth recorded instance of retinoblastoma in an adult. The tumor was observed clinically for three and one-half years and was studied microscopically. Pathologic section disclosed a cystic tumor below the optic nerve head, arising from the retina and showing the morphologic and staining properties of retinoblastoma.

DISCUSSION

Dr. F. H. Verhoeff, Boston: Of great interest to me was the fact that Dr. Rychener found a hole in the separated retina, for I have never found a hole in a retina separated as the result of a tumor of any kind. In this case, the hole was perhaps produced by the retina tearing away from the edge of an old chorioretinal adhesion.

I agree with Dr. Rychener that chronic chorioretinitis is not a primary cause of retinoblastoma. Nevertheless, in his case it does not seem impossible that without the resulting degenerative changes the anlage of the tumor might forever have remained dormant.

Dr. Georgiana Dvorak Theobald, Oak Park, Ill.: Duke-Elder raises the question whether the retinoblastoma originates from cell rests or is of spontaneous development. A tumor which I examined does not provide an answer, but the suggested long quiescent period adds weight to the theory of the cell rest origin.

Dr. Ralph O. Rychener, Memphis, Tenn.: Dr. Pischel has been quoted as saying that if a lesion in a case of detachment of the retina can be determined to be cystic it is most unlikely to be a tumor. The lesion in this case proved to be a tumor, and in two other cases in my practice I have observed cystic lesions of the retina, in 1 of which

operation was performed for retinal detachment and in both of which the lesion proved to be a solid tumor of the choroid; one must be careful, therefore, not to lay too much stress on the safety of a cystic lesion of the retina.

Familial Central and Peripapillary Choroidal Sclerosis Associated with Familial Pseudoxanthoma Elasticum. DR. WILLIAM BANKS ANDERSON, Durham, N. C.

A family pedigree was presented characterized by phenotypical physical traits, with choroidal sclerosis and pseudoxanthoma elasticum, in 3 of 4 siblings and 1 collateral member. The sibling not exhibiting pseudoxanthoma elasticum presented angioid streaks and a retinal lesion resembling retinitis punctata albescens. The collateral member exhibited pseudoxanthoma elasticum, choroidal sclerosis and, in addition, cortical cataract, attenuated vessels, waxy white disk and an atypical pigmentary disturbance. The literature was reviewed, with a presentation of the evolution of the concept of pseudoxanthoma elasticum as a familial disease and its association with angioid streaks and, in the cases reported in this paper, with choroidal sclerosis. The hypothesis is advanced that the choroidal sclerosis is due to, or at least associated with, degeneration of the elastic membrane of the vessel wall, a type of degeneration observed in the elastic element of Bruch's membrane (lamina basalis) and in the elastic fibers of the dermis. It is further postulated that this degeneration of the choroid is due to localized anoxemia produced by the changing pattern of the posterior ciliary arteries in the interlocking development of the orbital vascular and osseous system.

DISCUSSION

DR. HAROLD FALLS (by invitation), Ann Arbor, Mich.: The disease syndrome which Dr. Anderson has described developed in what may be assumed to have been fully differentiated tissues and may therefore be one of the so-called abiotrophic diseases. These ocular abiotrophies are hereditary, develop in different families at different periods of life, present varying manifestations within the same family but have recognizable similarities as to onset and course. There is much to suggest that these abiotrophic diseases may develop from disturbances in their intrinsic environment, and future studies in this field should employ the biochemist as a collaborator.

The data on this family are too incomplete to permit one to decide what mode of inheritance the trait assumes. The most likely pattern is that of a sex-linked recessive character, but much further study of the family is necessary to substantiate this belief.

DR. ARTHUR J. BEDELL, Albany, N. Y.: Dr. Anderson's paper opens many possibilities for discussion. One is the recurring reference to a purely local disease of the skin, pseudoxanthoma elasticum. It is my impression that the presence of this condition should be considered a mere coincidence. It is known that many patients with this atrophy of the skin are free from ocular involvement, and that ocular manifestations may be unassociated with the change in the skin.

The Scandinavian investigators Grönblad and Strandberg, with Carlborg and Günther, materially broadened the concept of angioid streaks

and pseudoxanthoma elasticum. Carlborg (Studies of Circulatory Disturbances, Pulse Wave Velocity and Pressure Pulses in Larger Arteries in Cases of Pseudoxanthoma Elasticum andAngioid Streaks: Contribution to Knowledge of Function of the Elastic Tissue and Smooth Muscles in Larger Arteries, *Acta med. Scandinav.*, supp. 151, pp. 1-209, 1944) presented evidence which has made it much easier to understand the frequent, but by no means constant, association of pseudoxanthoma elasticum and angioid streaks. He demonstrated that the elastic tissue deficiency was distributed throughout the vascular system and was not restricted to certain areas of the skin or to special parts of the eye. Dr. Anderson's report takes on a new significance when viewed in the light of this information, for it is not difficult to conceive of choroidal sclerosis associated with vascular lesions without either familial or dermatologic adjuncts.

Although the author cites the histories of 4 cases occurring in one family, the patients were all in the age group in which vascular degenerations are by no means infrequent.

Dr. Ralph I. Lloyd, Brooklyn: Depigmentation of the choriocapillaris and the pigment layer of the retina with opacity of the walls of the choroidal vessels is commonly seen in older persons, with surprisingly little effect on the vision other than an enlarged blindspot and contracted field. This clinical picture has been explained in part by Verhoeff and Martin Cohen, who have pointed out that the caliber of these opaque vessels may be unaltered. Sclerosis of the choroidal vessels is the first step in a series of senile changes, many of which have been given the status of clinical entities, but which are really stages of a progressive degenerative process. In this series one finds a hole in the macula, subretinal hemorrhages and exudates, appearing to the ophthalmoscope as pseudotumors of the macula, and these, in turn, passing on to Coats's disease (retinitis exudativa) and disciform degeneration of the macula. Time takes its toll chiefly of the elastic tissue in the vascular walls of the body, as in vascular sclerosis; in the skin, as in pseudoxanthoma elasticum, and in the vessels of the choroid and the elastic element of Bruch's membrane. The importance of changes in the lamina of Bruch in the various ocular lesions mentioned and in angioid stripes was first pointed out in 1915 by Axenfeld, but the later, and much more important, studies of Verhoeff, E. V. L. Brown, Cushman and Bertha Klien have shown the significance of breaks in the lamina of Bruch through which vessels from the choriocapillaris pass to the organized tissue beneath the retina in retinitis exudativa, disciform degeneration of the macula and angioid stripes.

Surgical Procedures in Retinal Vascular Disease. Dr. A. L. MacLean, Baltimore.

Perforating scleral diathermy with aspiration of the subretinal fluid is a safe and effective procedure in the treatment of serous retinal detachment complicating diabetic retinopathy. A glass applicator with a broad concave tip and controlled negative pressure supplied by an electric suction pump is a safe and effective means of aspiration of subretinal fluid if the draining opening in the sclera is not too large, if it

is not opposite a large retinal opening or if it is reasonably certain that the retinal opening has been adequately sealed off by previous diathermy.

Cervical sympathectomy was used effectively in 1 case in the treatment of bilateral occlusion of the central retinal artery. Noticeable increase in caliber of the retinal vessels occurred.

DISCUSSION

DR. GLEN G. GIBSON, Philadelphia: Dr. MacLean is to be congratulated on the improvement which he was able to secure in the treatment of these two very different and rare conditions.

It should be emphasized that the retinal detachments for which Dr. MacLean reports surgical success are not the usual variety associated with retinitis proliferans. Since it will be necessary to differentiate these two types of detached retina in order to decide which cases are suitable for surgical treatment, I shall ask Dr. MacLean to repeat the differential features of this rare serous type of detachment and those of the usual retinal detachment, which is due to retraction of the retina as a result of the proliferating mesoblastic tissue.

In the days before Smithwick it was the impression that the sclerosed vessels associated with hypertension were of rather constant caliber and would not dilate after sympathectomy. Experience has disproved this impression and has given lessons in the difficult work of evaluating the degree of angiospastic and angiosclerotic involvement of the retinal arterioles. By his application of a well known procedure to a rare and difficult condition, Dr. MacLean has achieved a most successful therapeutic result.

DR. A. L. MACLEAN, Baltimore: In the serous type, the picture of marked elevation of the retina with considerable subretinal fluid and reddish areas, resembling openings, is superimposed on that of severe diabetic retinopathy. Of course, when there is extensive organization, with firm tractional bands in the vitreous, one would not expect much or any help from the procedure described.

Epidemiology of Epidemic Keratoconjunctivitis. DR. PHILLIPS THYGESON, San Jose, Calif.

In the present study, transmission of epidemic keratoconjunctivitis was shown to have occurred by various means: (*a*) contaminated tonometers; (*b*) contaminated solutions, including tetracaine, cocaine-epinephrine and homatropine solutions; (*c*) direct finger to eye transmission, and (*d*) fomites, especially welders' masks, goggles and common tools.

No satisfactory evidence was obtained to indicate the presence of asymptomatic conjunctival carriers or carriers of respiratory infection.

In view of the high frequency of office transmissions, routine office practice should be reexamined in order that this and other infections may be prevented. The following prophylactic measures are to be recommended: (1) discarding of all dropper bottles; (2) use of individual, sterilizable droppers; (3) adequate hand washing before and after treatments; (4) use of disposable arm covers for the treatment chair; (5) provision of individual masks and goggles for workers in industry, and (6) early recognition and isolation of cases.

DISCUSSION

Dr. A. E. Maumenee, Baltimore: One of the most important points that Dr. Thygeson has brought out is the vulnerability of oculists' offices in spreading this infection. He has particularly condemned the use of the dropper bottle as a source of contamination. I have not seen epidemic keratoconjunctivitis spread by this method, but I know of 3 instances in which bacterial infections have been caused by contaminated solutions. In 2 cases infections of the cornea were due to the introduction of fluorescein contaminated with Pseudomonas aeruginosa, and in 1 instance a staphylococcic infection was produced by contaminated 10 per cent mild protein silver U. S. P. Dr. Thygeson has suggested that the use of dropper bottles should be discontinued and individual sterile droppers substituted. This is a good suggestion, but a better one might be to introduce into ophthalmic solutions a substance which would cause these solutions to be self sterilizing. Recently, McPherson and Wood investigated the use of 1:5,000 benzalkonium chloride U. S. P. in ophthalmic solutions and found it bactericidal for Escherichia coli, P. aeruginosa and staphylococcic contaminations. It is also possible to sterilize solutions contaminated with the viruses of herpes simplex and epidemic keratoconjunctivitis by the addition of methylene blue in 1:200,000 dilution to solutions and exposing them to light.

Dr. A. E. Braley, New York: Little was said about the virus. My colleagues and I have rather conclusively shown now that the virus must be isolated before the fifth day of the disease or it becomes fixed. We have not been able to isolate it after the fifth day. The development of antibodies to the virus occurs from two to three months after the disease has subsided.

Dr. Frederick C. Cordes, San Francisco: From my personal experience, it would seem that in the recent epidemic the percentage of patients with visual loss was much smaller than that in the epidemic of 1941. In addition, the course of the disease was milder and of shorter duration. Incidentally, as judged from the reports, by the time the epidemic of 1941 reached the Atlantic seaboard it had assumed a much milder form.

Dr. Charles A. Perera, New York: I have seen a case in which treatment for a corneal foreign body was followed by a stubborn iridocyclitis and an extensive abrasion of the cornea. In another case the abrasion of the cornea followed the use of the tonometer. Any ophthalmologist may see such eyes; he may not recognize the condition as epidemic keratoconjunctivitis.

Dr. Phillips Thygeson, San Jose, Calif.: I have little to say about treatment. I hoped that Dr. Braley would say a word about serotherapy and the use of aureomycin, as he and Dr. Sanders have done most of the work on therapy.

Dr. Cordes referred to the mildness of the disease in his cases. My impression was somewhat to the contrary. Two of the patients whom I cared for had true membranes, and the prognosis for the integrity of the eye was alarming. I reexamined both these patients after recovery and found that both had formation of symblepharon in the lower fornices. It has been my impression that the second epidemic was accompanied with greater visual loss. It has seemed to me that, in

addition to the typical round areas of infiltration, there has been a greater frequency of irregular infiltrations between the round areas. It is true that one eye may be severely affected and the second mildly, or a husband may have a severe and a wife a mild infection. There is undoubtedly a great variation in the clinical picture, but I have been impressed with the severity of the disease.

Ocular Lymphomas. Dr. Parker Heath, Boston.

The commonest cytologic type in this series is the lymphocytoma. There are noted other cell types, however, i. e., lymphoblastoma, reticulocytoma and plasmocytoma. The prognosis is not materially altered by the cell type. The lymphomas occur oftener in the first decade and after the fifth decade of life. They respond to roentgen treatment in small doses and to excision when the size permits. Long periods of remission may follow treatment. Lymphomas of the lid and orbit are like those elsewhere. If early, small, discrete and primary, the immediate effects of removal and roentgen therapy are good; the remote effects are poor.

The conjunctival part of this series offers features similar to those in the group of lymphomas reported by Schulz and Heath; that is, the primary lymphomas of the orbit and conjunctiva are rare and were responsible for less than 1 per cent of a total of 1,671 ocular tumors in that series. The primary conjunctival lymphoma is relatively benign if there has been no extension of the process at the time of treatment. A long interval may elapse before general involvement takes place. If the conjunctival lesion is extending and sarcomatous, the prognosis is that of lymphoma elsewhere—in time invariably fatal.

DISCUSSION

Dr. Georgiana Dvorak Theobald, Oak Park, Ill.: Our experience at the Illinois Eye and Ear Infirmary confirms Dr. Heath's findings in regard to the incidence of these tumors.

Dr. A. J. Bedell, Albany, N. Y.: In 1921 I reported a case of lymphoma before the Academy of Ophthalmology and Otolaryngology. The patient was then 52 years of age, and the lesion was, as shown in the illustration, a pericorneal mass. It was round, pink and edematous. The growth was excised and the diagnosis verified. In 1922 there was a marked recurrence with involvement of the upper half of the globe. This responded to radium. In 1928, faint anterior opacities in the cortex of the lens were present for the first time. A year later there was another recurrence of the lymphoma, almost as extensive as before. The patient was again treated with radium, with a satisfactory result. In 1935 there was pronounced limitation of the motion of the globe outward, with an oval mass about 2 cm. long and 6 mm. wide in the upper portion of the orbit. The cornea was almost completely encircled by an elevated, solid red tumor with several nodular masses on the lower portion of the eyeball. There were definite opacities in both the anterior and the posterior cortical layers of the lens. At this time she was given roentgen treatment, and the tumor completely disappeared.

In 1939 vision was reduced to the counting of fingers. The cataract was removed without difficulty or complications, and healing was prompt.

Unfortunately, there developed abdominal symptoms; she lost a great deal of weight and died two months later. Autopsy was not permitted. This detail is given as a follow-up report to the previous communication to emphasize the recurring nature of the lesion—in this instance, the terminal abdominal extension with severe intestinal hemorrhages.

Dr. Alexander E. McDonald, Toronto, Canada: Reticulum cell sarcoma is closely linked with lymphoma and presents similar diagnostic difficulties. For example, a provisional diagnosis of sarcoidosis was changed at autopsy to that of reticulum cell sarcoma in the case of a man aged 38 with bilateral blindness. He showed the signs of intense uveitis; the iris was discolored and studded with nodules.

Dr. Parker Heath, Boston: The clinical course is ineluctable, and lymphoma ultimately becomes generalized. There is a widespread idea that the conjunctival involvement is isolated and benign. Our study shows that when the conjunctival lesion is very small and is removed when first seen, half the patients ultimately have the usual clinical consequences of generalized disease.

Perineuritis Optica. Dr. A. J. Bedell, Albany, N. Y.

Four cases are recorded with serial photographs of the fundus. They presented unusual signs, which temporarily confused the diagnosis. These cases point to the great importance of photography in clinical ophthalmology.

Aerobic Glycolysis of Corneal Tissue. Dr. P. J. Leinfelder, Iowa City.

1. Aerobic glycolysis of rabbit corneal tissue takes place in the presence of added substrate. The maximum rate occurs when the concentration is above 0.6 mg. per cubic centimeter.

2. Great variation is observed in the oxygen consumption of rabbit corneas, the average value being + 1.8.

3. Corneal epithelium accounts for approximately two thirds of the value for whole corneas.

4. Corneal tissue survives without an exogenous supply of dextrose, and normal values can be obtained for aerobic glycolysis by adding dextrose three and three-fourth hours after the beginning of the experiment.

5. Without dextrose, corneal tissue retains and absorbs carbon dioxide.

DISCUSSION

Dr. P. C. Kronfeld, Chicago: While Dr. Leinfelder's results are in part rather complex and difficult to interpret, in principle they show that the metabolism of the cornea differs from that of other tissues only in respects that could have been predicted from its anatomic situation and histologic structure. The concentration of cells along the anterior surface and the scarcity of such cells in the deeper layer make it understandable why the oxygen consumption of the epithelial layer is approximately of the same magnitude as that of the parenchyma of the liver, while the oxygen consumption of the stroma is minimal, if not zero. The small caloric needs of the stroma are apparently covered chiefly by glycolytic

activity, which represents a considerable proportion, namely, one third, of the glycolytic activity of the whole cornea, as Dr. Leinfelder has shown. There also seems to exist a form of symbiosis between the epithelium and the stroma of the cornea in the sense that the epithelium uses some of the lactate which the stroma is not able to utilize. If one may apply these laboratory findings to the probable behavior of the cornea in vivo and in situ, one would expect the cornea to draw heavily on the glucose present in the neighboring tissues. This is made highly probable by data obtained with other methods. In other words, it is probable that the cornea takes glucose out of the aqueous and out of the tissue fluid entering through the limbus.

Dr. Leinfelder's findings have also shown again the well known ability of the cornea to survive under conditions of storage. While I do not know of any direct clinical application of these findings, I believe we are indebted to Dr. Leinfelder for having given us another piece of important basic ophthalmologic knowledge.

Effect of Retrobulbar Anesthesia on the Intraocular Tension and the Vitreous Pressure. DR. HAROLD GIFFORD JR., Omaha.

This study indicates that in the normal eye a dynamic factor, controlled by the nervous system, produces a certain amount of the intraocular tension. This factor seems to be relatively constant, amounting to about 33 per cent of the initial intraocular tension. It is influenced by the tonus of the extraocular muscles and the parasympathetic activity of the third nerve. It can be distinguished from the total intraocular tension by an orbital injection of 2 per cent procaine hydrochloride with epinephrine hydrochloride 1 : 1,000 or by thiopental sodium anesthesia. This leaves a residual, or basal, pressure which shows a tendency to increase slightly in the normal eye as the intraocular pressure rises. This basal pressure is maintained by still unknown factors, but must in some way be associated with the hydrostatic pressure of the blood and the elasticity of the sclera.

This study indicates that in the glaucomatous eye the basal pressure becomes elevated, in some eyes to such a degree that there is produced an anatomic change which resists all tension-lowering devices, such as drops, orbital injection, section of the rectus muscles and even enucleation.

DISCUSSION

DR. EDWIN B. DUNPHY, Boston: The one significant correlation is that made between the percentage fall in tension and the degree of motor block following the injection—the more efficient the motor block, the greater is the percentage lowering of tension.

The mechanism by which the reduction of tension is accomplished is not entirely clear. The fact that epinephrine appears to play a minor role interests me greatly, for I thought it had a definite effect. The statistics show that the more complete the motor block in cases of cataract the greater is the percentage fall of tension. However, certain exceptions occur, in that a good reduction may be effected with a poor motor block. This suggests some factor other than relaxation of the extraocular muscles. Speculation on this would range through the field of ocular physiology and pharmacology, involving the effect of abolishing the parasympathetic nerve impulses, but time does not permit it.

DR. WALTER B. LANCASTER, Boston: For many years I have maintained that the extraocular muscles, rather than the lids, were an important factor in squeezing, but have not received much backing in that idea. The obvious thing is that the lids squeeze; one does not see the extraocular muscles behind the lids, but they do the mischief.

DR. P. C. KRONFELD, Chicago: In Dr. Gifford's series the retrobulbar injection of procaine had one of two effects: It either lowered the ocular tension or had no effect. The ocular tension was lowered in all the cases of cataract, in the control cases and in most of the cases of glaucoma. In a few cases of glaucoma the tension was not lowered, and it seemed to be characteristic of the hemorrhagic glaucomas that the tension was not lowered by the retrobulbar injection. That the ocular tension in certain types of glaucoma is not lowered by the injection is well known, but it would not be correct to say that the eye of the glaucomatous patient does not respond to retrobulbar injections of procaine. I have used retrobulbar injections in many cases of acute narrow angle glaucoma, and in a large majority there was a lowering of the ocular tension.

Choice of a Miotic Agent for Use After Retrobulbar Anesthesia. DR. HAROLD G. SCHEIE and DR. GAYLOR OJERS (by invitation), Philadelphia.

Retrobulbar injection of procaine temporarily produces an effect identical with the removal of the ciliary ganglion. The pupil is dilated and fixed and fails to constrict with physostigmine, but does so promptly with pilocarpine.

Evidence therefore suggests that if a miotic is to be employed after cataract extraction done with retrobulbar anesthesia, pilocarpine is preferable to physostigmine because the latter is rendered ineffective by the injection.

Paredrine hydrobromide ophthalmic[9] (a 1 per cent solution of *p*-hydroxy-α-methylphenylethylamine hydrobromide in distilled water, made tear isotonic with 2 per cent boric acid and preserved in merthiolate 1:10,000) is theoretically a more ideal preoperative mydriatic agent than homatropine because it is much more readily counteracted by pilocarpine. Although ordinarily a weak mydriatic, the retrobulbar injection of procaine adds to its effectiveness through paralysis of the sphincter pupillae.

If mydriasis is to be prevented after retrobulbar injection of procaine, particularly as used in the treatment of acute congestive glaucoma, pilocarpine should be used beforehand.

The Harrington Tonometer. DR. DAVID O. HARRINGTON, San Francisco.

The Harrington tonometer is a multiple weight instrument similar in principle and basic specifications to the Schiøtz tonometer. It utilizes the 1924 Schiøtz nomogram to convert the mechanical measurement of corneal indentation into terms of millimeters of mercury. Its main bearings are jeweled, and when held in a vertical position it is practically frictionless.

The lever ratio is such that the spacing of the scale reading is 5.7 times that of the spacing on the Schiøtz instrument. Readings are thereby facilitated and troublesome parallax is eliminated. The dial is

designed so that with the 5.5 or 7.5 Gm. weights direct readings of intraocular pressure in millimeters of mercury are provided, and recourse to a nomogram or conversion table is unnecessary for these two weights.

For higher pressures, necessitating the use of the 10 or 15 Gm. weights, a conversion table is supplied.

Vascularization of the Cornea: Its Experimental Induction by Small Lesions and a New Theory of Its Pathogenesis. Dr. David G. Cogan, Boston

This paper was published in the April 1949 issue of the Archives, page 406.

Enucleation and Allied Procedures: A Review and Description of a New Operation. Dr. Jack S. Guyton, Baltimore.

About five years ago Dr. Conrad Berens remarked to me that a measure which should always prevent a buried implant from becoming displaced outside the muscle cone would be the suturing of the rectus muscles together through tunnels in the implant. Application of this idea to an "exoplant," adapted for an attachable prosthesis, seemed logical, for there was histologic evidence that epithelium grew around and lined the smooth posterior portions of the original Ruedemann and Cutler implants. It seemed likely that epithelium would also grow around the muscles where they passed through smooth tunnels, provided the raw surfaces of the muscles were not pressed too tightly against the tunnels while epithelization was taking place; this proved to be the case. The term "exoplant" has been coined to denote that there is contact only with epithelized surfaces (once healing is complete), in contrast to the situation with semiburied implants.

The exoplant is in the shape of a truncated cone on a hemispherical base, with two oval holes or tunnels piercing it perpendicular to its vertical (anteroposterior) axis and at right angles to each other, and with a cup inset in its anterior surface. It is made in two sizes: The large size is designed for insertion at the time of enucleation, and the small size, for delayed implantation or reimplantation. In both sizes the anterior surface is 12 mm. in diameter. The exoplants available at present are composed of methyl methacrylate, inset with a "vitallium" cup.

The operative technics are described.

Insertion of Exoplant at the Time of Enucleation: A pericorneal incision is made through the conjunctiva; Tenon's capsule is separated from the globe, and the insertion of each rectus muscle is exposed, without disturbing its capsule. A double-ended, braided 00000 nylon suture, threaded and locked on ski needles 20 mm. in length, is inserted through the tendon and capsule of each rectus muscle about 2 mm. from its insertion, in such a manner as to form a double lock stitch. Each rectus tendon is then divided at its attachment to the globe. The optic nerve is cut, and the tendons of the oblique muscles are cut at their insertions, care being taken not to damage Tenon's capsule.

It is not necessary to wait until bleeding has completely subsided before inserting the exoplant, because blood may seep out around it for a short time after operation, but the bleeding should not be brisk.

Both ends of the suture attached to the superior rectus are passed through one of the tunnels of the exoplant. Tenon's capsule is divided for several millimeters back along each side of the muscle, just enough to permit the end of the superior rectus to be pulled completely through the tunnel and sutured to the tendon of the inferior rectus by means of the previously placed sutures, so that the tendons overlap each other 3 or 4 mm. Both ends of the suture attached to the internal rectus are then passed through the second tunnel of the exoplant, passing over the united vertical rectus muscles, and the end of the internal rectus is drawn completely through the second tunnel and sutured to the end of the external rectus. The exoplant is now straightened into such position that the anterior face tilts upward 2 to 3 mm. above the horizontal. This slight upward tilt allows for the slight downward rotation which will result from supporting the weight of the final prosthesis and the upper lid. The edge of the conjunctiva and the anterior termination of Tenon's capsule are now tacked to each rectus muscle by means of a 00000 plain surgical gut suture. These sutures are so placed as to hold the exoplant in proper position, by causing the conjunctiva and Tenon's capsule to press snugly enough against the pillars separating the tunnel openings to prevent the exoplant from tilting out of position before the muscles adhere. A plastic conformer, with a large central opening to permit free drainage of any serous or mucoid discharge or of any postoperative bleeding which seeps around the sides of the exoplant, is placed in the socket to maintain the conjunctiva in proper position in the fornices. A monocular dressing is applied without pressure.

Insertion of Exoplant into a Socket When Enucleation Has Previously Been Performed: This procedure is dependent on identification and isolation of the rectus muscles.

Insertion of 45 exoplants (25 as initial and 20 as secondary procedures) at the Wilmer Ophthalmological Institute during the past twenty months has given cosmetic results equal to those obtained with any of the semiburied implants, and as yet there have been no late complications.

Amblyopia ex Anopsia: Observations on Retinal Inhibition, Scotoma, Projection, Discrimination of Light Differences and Visual Acuity.
DR. S. RODMAN IRVINE, Los Angeles.

Verhoeff observed that patients with nonparalytic strabismus failed to note apparent displacement of a fixated light by the cover test (absence of binocular Φ phenomenon) because the percipient elements of the retina involved in the angle of squint have the same directional value as the macula of the fixing eye. This observation suggested the following possibility, namely, that with one eye fixing, if prisms of varying strengths were moved before the strabismic eye, displacing the image in varying amounts within the angle of squint, the image would not be seen or, if seen, would be falsely projected. Furthermore, it suggested that moving prisms before an eye might be used to study projection, inhibition and scotoma in cases of strabismus and amblyopia. Amblyopia based on organic macular lesions might be differentiated from amblyopia ex anopsia if retinal inhibition and projection were more altered in amblyopia ex anopsia. In general these suppositions were verified.

Scotoma, retinal projection and retinal inhibition were studied in patients who had amblyopia ex anopsia of various grades. The prism displacement test was used, as well as the usual methods for obtaining data on these conditions. The results are summarized as follows:

Group 1: Persons with severe amblyopia, with gross inability to fixate but with the eye held in the primary position, showed an area of relative inhibition between the disk and the macula, with a smaller absolute scotoma, either adjoining the nasal side of the macula or on the temporal side of the disk.

Group 2: Patients with amblyopia but with eccentric fixation showed the same type of centrocecal or cecocentral scotoma, but the false retinal projection in the area adjoining the absolute scotoma was firmly fixed as to directional value.

Group 3: Patients with amblyopia with strabismus and relatively good ability to fixate all showed increased amplitude of fixation movements, as compared with the normal eye or with eyes with organic macular disease. These patients showed degrees of inhibition at the angle of squint varying from absolute scotoma to mild facultative inhibition. Infrequently a small scotoma touching the side of the macula was involved in the angle of squint. Between the area of inhibition at the angle and the macula, degrees of faulty projection, varying from fixed false to indefinite projection, were found. No subject with strabismus was seen in this group that showed normal projection to the prism displacement test, a finding in keeping with Verhoeff's contention that all patients with nonparalytic, constant strabismus show faulty retinal projection, as judged by absence of the binocular Φ phenomenon in the area of the angle of squint.

Group 4: Patients with amblyopia without strabismus or with inconstant strabismus showed normal retinal projection outside the central area of inhibition. Anisometropia was found in most cases. A facultative type of central or paracentral scotoma was usually present, and rarely there was a very small absolute scotoma. The scotoma is too small to account for the visual acuity. The relatively poor fixation is an important contributing factor. Retinal rivalry can be elicited and might afford a mechanism whereby the nondominant eye could be easily inhibited, preventing development of the fixation reflex. However, all patients with anisometropia do not become amblyopic, and other factors, such as congenital defects, must be considered in the etiology.

Group 5: In order further to elucidate the role of scotoma in explaining visual acuity of patients with amblyopia ex anopsia, 30 patients with acquired organic macular disease were studied. In these patients the scotoma was large as compared with that associated with amblyopia. Notwithstanding the larger scotoma, the visual acuity was much less reduced. Fixation was steadier, and projection was normal.

Evaluation of Night Vision. Dr. Phillip R. McDonald, Philadelphia.

Practically all the tests developed during the war had one thing in common: They measured the threshold for form rather than for light. In the experiments reported, the tenfold variation in the final threshold of rod vision in healthy young adults confirmed the findings of other investigators. The two tests for night vision employed—one a test of the

visual threshold to a flash of light and the other the recognition of a 2 degree *C*—both showed good reproducibility, or test-retest, reliability. It was also shown that the visual threshold in normal persons is not improved with large doses of vitamin A.

The ideal of any test of night vision is that from the results one may eliminate the poor and select the best subjects for special assignments that may involve night operations. As is frequently the case, the ideal is seldom achieved.

Most of the men who complained of difficulty in performing their assigned duties at night were found to have normal night vision. (Such complaints are frequently the earliest manifestation of anxiety.) Despite this, however, it is believed that a test of night vision for all military personnel is worth while—some cases of night blindness are always discovered on routine examination, especially in groups less highly selected than cadets. Also, with the vast majority of subjects this test is the first demonstration they have ever had that at low levels of illumination peripheral vision is many times better than central vision.

Surgical Treatment of Recurrent Pterygium. Dr. John S. McGavic, Bryn Mawr, Pa.

An operative technic developed to eradicate severe pterygiums which had recurred from one to twelve times in a group of Army patients was described. Some of the patients had symblepharon, ptosis and limitation of motility as a result of the extensive scar tissue.

Although the series of patients was small, the results were good after other procedures had failed to prevent recurrence. The procedure was therefore offered for trial by others with the hope that it would be of value in those sections in which recurrences are more frequent and troublesome. The technic is simple and safe, and the essential feature is based on logical surgical principles.

The procedure consists, in brief, of lamellar keratectomy, submucous resection of all scar tissue, recession of the conjunctiva by suturing it to the sclera proper at least 5 mm. from the corneoscleral junction and leaving the denuded cornea and sclera to become epithelized. Postoperative beta irradiation is used when necessary, to control vascularization. This simple technic has also been found suitable for pseudopterygium, excision of epibulbar tumors, repair of symblepharon and removal of superficially vascularized corneal scars.

Recession of the conjunctiva allows deepening of the contracted fornices, with consequent relief of ptosis, symblepharon and diplopia. Revascularization is likewise avoided. No ill effects were observed from leaving the denuded cornea and sclera to become epithelized.

Although this procedure was developed without known precedent, it was not surprising to find, on review of the literature, that it is a combination of surgical principles and technical details most of which had been described piecemeal many years ago and then neglected over a considerable span of years.

Direct Surgery of Paretic Oblique Muscles. Dr. J. M. McLean, New York.

This paper was published in the July 1949 issue of the Archives, page 50.

Ocular Effects of the Choline Esters. Dr. Kenneth C. Swan, Portland, Ore.

Dibutoline sulfate (dibutylcarbamate of dimethylethyl-β-hydroxyethyl ammonium sulfate), in the intensity of its mydriatic and cycloplegic action, is comparable to homatropine; but it is less consistently absorbed into the cornea, and some patients are refractory to its action. When preceded by a topical anesthetic, dibutoline is more consistently absorbed and is sufficiently potent to be used as a routine cycloplegic in older adults. It has the advantage that the visual disability which it causes is not so prolonged as that of homatropine, and the size and reactivity of the pupil provide a convenient indication of the degree of cycloplegia. The drug has low systemic toxicity; therefore, it is useful as an adjunct to scopolamine or atropine in producing cycloplegia in children.

In the management of corneal inflammations, dibutoline is valuable because it has detergent and antiseptic action and its mydriatic and cycloplegic effects are not unduly prolonged. Dibutoline is not ideal for the routine treatment of uveitis but fills an important need when the patient is allergic to the atropine series of drugs.

CORRECTION

The transactions of the Jan. 21, 1948 meeting of the New England Ophthalmological Society, which appeared on pages 790 and 791 of the April issue of the Archives, were inadvertently omitted from the table of contents.

Book Reviews

Transactions of the Ophthalmological Society of the United Kingdom —1948. Volume 68. Pp. 591. J. & A. Churchill, Ltd., 104 Gloucester Place, Portman Sq., London, 1949.

The chief content of the *Transactions* concerns the proceedings of the annual congress of the Ophthalmological Society of the United Kingdom during its session in April 1948. With this society are affiliated eight other ophthalmologic societies, the meetings of which are reported in the same volume. The list of papers presented at the Ophthalmological Society of the United Kingdom is as follows:

I. Discussion: Subjective Disorders of Vision (Excluding Those Due to Local Ocular Disease). Symposium opened by Prof. Henry Cohen, with papers by Denis Williams and James Doggart, followed by a general discussion.

II. The Bowman Lecture: New Clinical Aspects of the Vegetative Eye. Marc Amsler, Zurich.

III. Glaucoma

The Venous Pressure in Glaucomatous Eyes. T. L. Thomassen.

A Preliminary Survey of 44 Consecutive Cases of Congestive Glaucoma. J. P. F. Lloyd.

Atropine in the Treatment of Glaucomatous Iridocyclitis. W. H. Melanowski.

IV. The Fundus and Optic Nerve

The Classification of the Unassociated Dystrophies of the Fundus. Arnold Sorsby.

Prognosis in Detachment of the Retina. C. Dee Shapland.

The Mode of Development of the Vascular System of the Retina, with Some Observations on Its Significance for Certain Retinal Diseases. I. C. Michaelson.

The Papilloedema of Toxic Hydrocephalus. A. G. Cross.

V. Miscellaneous Papers

Latent Nystagmus. T. Keith Lyle.

Ocular Palsies Due to Infection of the Nasal Sinuses. Helen Dimsdale. D. G. Phillips.

Auto-Eversion of Upper Eyelid(s), Voluntary, Unaided (Mimical Ectropion of Upper Lids, of S. Holth). W. C. Souter.

The Conjunctival Nævus and the Neurogenic Theory of Melanomata. Eugene Wolff.

Some Observations on Clinical Perimetry. G. I. Scott.

Case I. A Case of Sub-Conjunctival Rupture of the Globe. G. T. Willoughby Cashell.

Case II: A case of Arterio-Venous (Racemose) Aneurysm of the Retina. G. T. Willoughby Cashell.

Diabetic Cataract in a Case of Diabetic Cachexia. E. Grom.

Elephantiasis of the Eyelids. E. Grom.

VI. Pictorial Demonstrations

Spasm of Central Artery of Retina. H. M. Traquair.

Entoptic View of Retinal Vascularization. Maurice W. Paterson.

Pressure Grafting in Contracted Socket. J. Ellison.

Epibulbar Dermoid Before and After Operation. J. Ellison.

Gummatous Ulceration of the Eyelid. J. Ellison.

VII. Royal Society of Medicine, Ophthalmological Section

Scleral Resection for Detached Retina. S. Philps.

Large Keratocele Treated by Keratoplasty with Cadaver Cornea. Harold Ridley.

A Case of Glioma Retinae Treated with Radon. A. C. Houlton.

Traumatic Avulsion of the Iris. A. C. Houlton.

Hyaline Membrane in the Anterior Chamber. P. D. Trevor-Roper.

Choroidal Sclerosis. P. D. Trevor-Roper.

Cyst of the Ciliary Epithelium. P. D. Trevor-Roper.

Congenital Massive Choroiditis. A. G. Cross.

Angiomatosis Retinae. S. Miller (for T. K. Lyle).

Exophthalmic Ophthalmoplegia. H. Ryan (for T. K. Lyle).

Lacrimal Gland Tumour. E. F. King.

Toxic Amblyopia. E. F. King.

Nystagmus. S. Miller (for T. K. Lyle).

Herpes Zoster with Complete Ophthalmoplegia. Arthur Lister.

Interstitial Keratitis with Associated Syphilitic Penile Lesions. A. Lister.

Spectacle Fitting and Optical Dispensing. By L. S. Sasieni. Price, 30 shillings. Pp. 294, with 200 illustrations. Hammond, Hammond, Hammond, Hammond & Co., Ltd., 87 Gower St., WC 1, London, 1949.

This book deals with methods of handling the essential problems of the dispensing of spectacles and of frame fitting. The first chapters describe the materials and types of frames available and the methods for their measurement. Considerable space is devoted to various rules and their use in obtaining facial measurements and to the selection of suitable styles and lens-eye shapes according to the facial characteristics, with a chapter on special purpose frames. Next are discussed the verification and the actual recommended methods of finally adjusting both metal and plastic frames to the facial measurements. A chapter

is given to the problems of locating the position of the optical centers of lenses, with special reference to bifocal lenses and to special types of lenses for correcting high hypermetropia and myopia. Finally, general precautions to be taken in avoiding errors in writing prescriptions and ordering the spectacles are noted.

The book deals, of course, with the types of frames and spectacles currently used in England, and in many instances these are no longer popular in this country. For example, covered frames have not been used here for nearly twenty-five years, and the saddle bridge frames, the adjustment of which is considered at some length, are seldom ever used now. As a consequence, the material of the first chapter is generally obsolete so far as the practices in this country are concerned.

The chapters devoted to rules and methods for accurately determining the frame data from facial measurements are interesting, and these procedures might be practical where spectacles are sent to the patient by mail. However, in this country the frames are usually adjusted directly to the patient at the dispenser's table, and such careful measurements are seemingly unnecessary and time consuming. Such measurements may also be difficult to interpret, especially by other dispensers. The precise centering of the spectacle lenses, except those of high power, is not as important as these chapters would imply. However, the particular face ruler illustrated (page 146) would be of considerable value in this country when special custom-made frames have to be made from time to time to fit unusual facial features.

The lens shapes described are essentially the same as those available in this country, as are their selection according to facial contours. Likewise, the various types of lenses and bifocal glasses described are essentially those available here. Several special types of lenses are of interest; for example the "rotoid" lens, which gives a wide field of vision with a small amount of aberration, has the outside curve ground with a radius equal to the distance of the lens from the center of rotation of the eye. Little space is given to tinted and plastic lenses.

The book will be primarily of interest to the beginner in optical dispensing and would be of value to the ophthalmologist in this country only for his general professional background.

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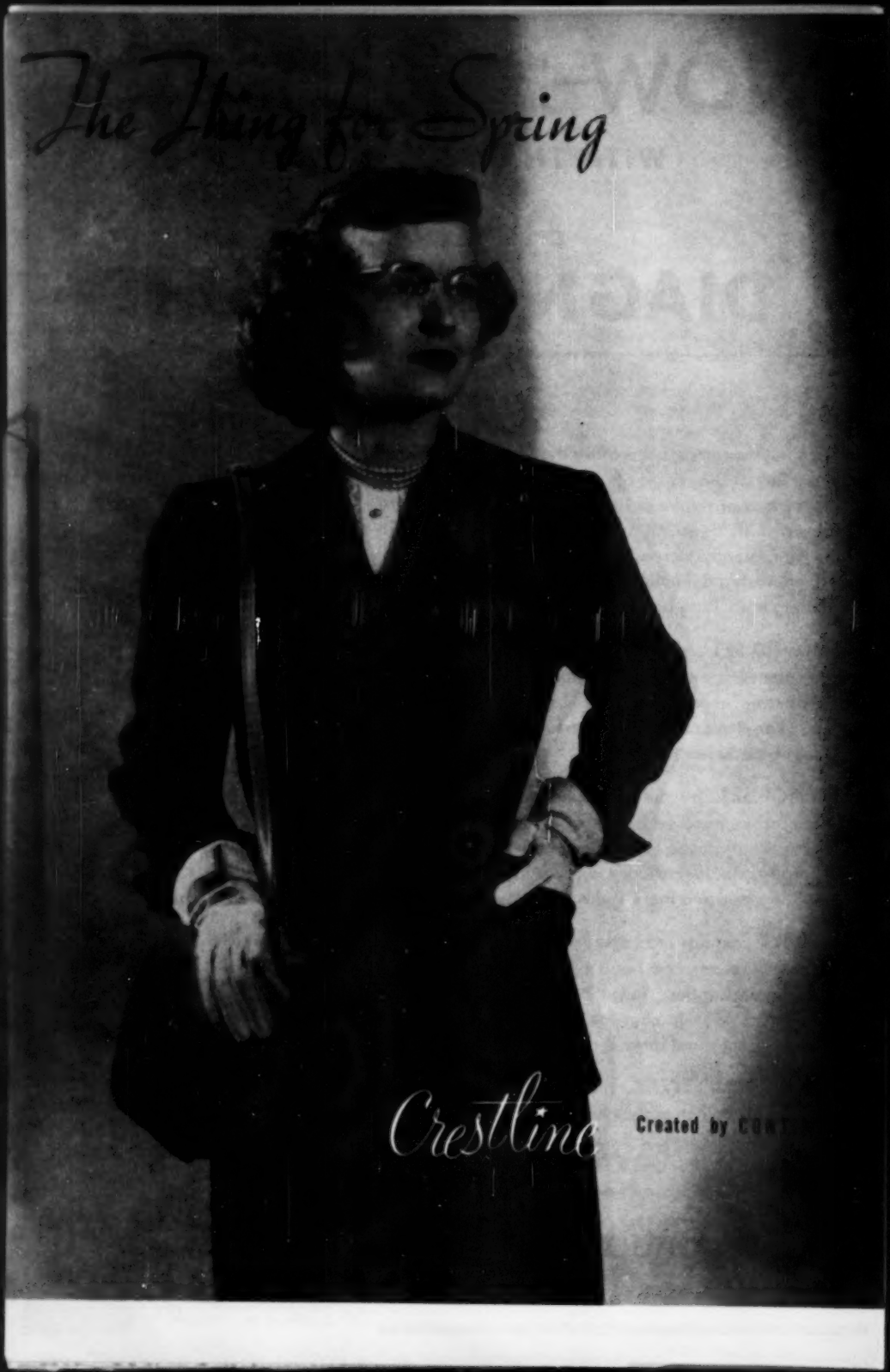
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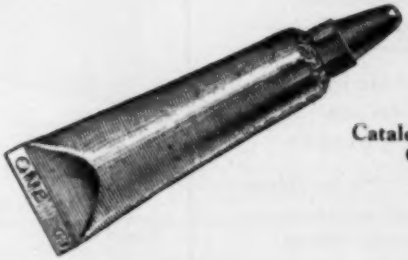

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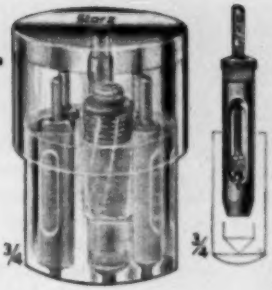

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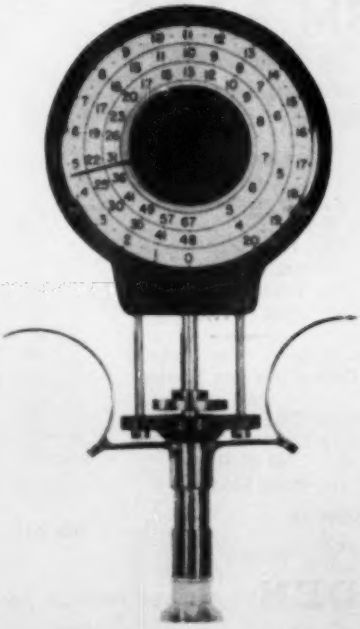

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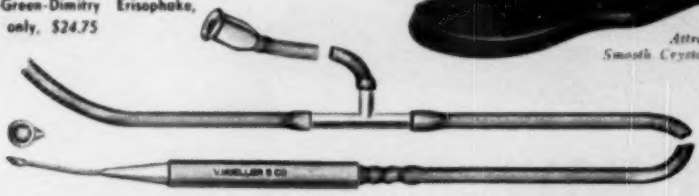

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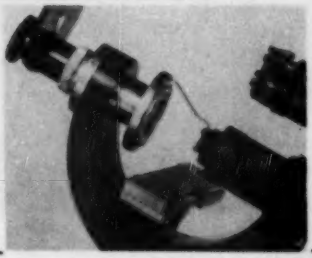

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